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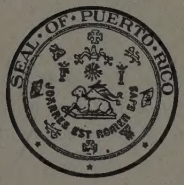

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THE CRANE-FLIES OF PUERTO RICO

(Diptera)

By CHARLES P. ALEXANDER
Massachusetts State College, Amherst, Massachusetts

INTRODUCTION

At the suggestion of my friend, Dr. M. D. Leonard, I have prepared the following brief account of the Tipulidae of Puerto Rico. Although much has been done in the collection of specimens, still further work will unquestionably add materially to the subjoined record. The following is the plan of the present report:

I. Historical Account.
II. Distribution of Genera and Subgenera in the Greater Antilles.
III. Keys to the Subfamilies, Tribes, Subtribes, Genera and Subgenera of Tipulidae known from the Greater Antilles.
IV. A record of the Tipulidae known from Puerto Rico, with keys and brief diagnoses of the species.
V. A list of the Tipulidae known from the Greater Antilles.

A very few species and subspecies, not only from Puerto Rico, but from other islands, are described at this time in order to complete the data. All types of these novelties are preserved in my collection.

During the progress of this survey of Neotropical Tipulidae invaluable co-operation has been received from many persons and institutions. I here wish to acknowledge the kindly help of the following, who have been of especial service in adding to our fragmentary knowledge of the Tipulidae of the West Indian Islands. Cuba: Julián Acuña, Joseph Bequaert, S. C. Bruner, J. G. Myers, A. Otero, G. C. Rowe, P. D. Sanders. Hispaniola: H. L. Dozier, J. G. Myers. Jamaica: G. C. Crampton, C. C. Gowdey, J. G. Myers. Puerto Rico: Charles Bates, W. A. Hoffman, W. T. M. Forbes, M. D. Leonard.

In addition to the above, the collections of the American Museum, with additional material secured by Grossbeck in Jamaica, and by Lutz, H. E. Crampton, Mutchler and others in Jamaica and Puerto

Rico; the British Museum material, through the kindly interest of Dr. Fred W. Edwards; and the United States National Museum, with early specimens taken by Busck, Schwarz and Richmond, should be mentioned.

The rich Antillean collections in various American institutions are due almost entirely to the efforts of the above men, here gratefully acknowledged. From the following account, it will be seen that the collections made by Messrs. Acuña, Bruner, G. C. Crampton, Gowdey, Hoffman, Leonard and Myers are by far the largest and most important.

I wish to thank my old-time friend and co-worker on the Tipulidae, Dr. Mortimer D. Leonard, for much kindly help and advice at frequent periods in the past quarter century.

I. Historical Account

The first Tipulidae ever taken in Puerto Rico would appear to be those now preserved in the Berlin Museum, collected previously to 1850 by Moritz, and described by Loew in 1851 (*Limonia (Geranomyia) rufescens* and *Toxorhina fragilis*) and by Osten Sacken in 1887 (*Brachypremna unicolor* and *Helius albitarsis*). Still later, Dr. Juan Gundlach collected in various parts of the island, his material forming the basis for the important paper by von Röder in 1885 (*Hexatoma trifasciata* and *Megistocera longipennis* Macquart).

Subsequent to the Spanish-American war and the transference of Puerto Rico to the United States, various officials from the United States National Museum (August Busck in 1899, Charles W. Richmond in 1900) made collections of insects in Puerto Rico, these including a few species of Tipulidae (*Dolichopeza portoricensis, Trentepohlia niveitarsis*). During the period of the World War, an expedition under the joint auspices of the New York Academy of Sciences and the American Museum of Natural History made extensive collections in Puerto Rico and other islands of the Antilles, the insects being taken chiefly by Messrs. H. E. Crampton, Lutz and Mutchler, and being discussed in detail in the comprehensive report by Curran (Scientific survey of Puerto Rico and the Virgin Islands, vol. 11, part 1. Insects, Diptera or two-winged Flies, pp. 1–118, 39 figs.; 1928). This records a total of 11 species of Tipulidae. During this same general period, a few species of Tipulidae were collected by Mr. R. H. Van Zwaluwenburg and were sent by him to the United States National Museum (including *Hexatoma ocellifera*). Wolcott (Insectæ Portoricensis. Journ. Dept. Agr. Puerto Rico, vol.

7: 1–313; 1923) recorded 9 species of Tipulidae from the island. In more recent years the present writer has described a number of additional species of Tipulidae, these being recorded in the present report. The total number of species of this family now known from Puerto Rico is 31, to which number many additions will surely be made as a result of future collecting. The mountainous region embraced in the Luquillo National Forest, culminating in El Yunque, will surely yield additional species, some of which will be endemic. This particular part of the island is of unusual interest, several species apparently being restricted to this region.

II. Distribution of Genera and Subgenera in the Greater Antilles

The accompanying table will show the present distribution of the genera and subgenera of crane-flies in the islands.

Genus and Subgenus	Cuba	Hispaniola	Jamaica	Puerto Rico
Tipulinae				
Nephrotoma	*	*	—	—
Tipula	*	—	*	—
Dolichopeza – Megistomastix	*	—	—	*
Brachypremna	*	*	—	*
Megistocera	*	*	—	*
Limoniinae				
Limonia–Limonia	*	—	*	*
— *Discobola*	*	—	*	—
— *Neolimnobia*	*	—	*	*
— *Dicranomyia*	*	*	*	*
— *Rhipidia*	*	*	*	*
— *Geranomyia*	*	*	*	*
Helius–Helius	*	—	*	*
Orimarga–Orimarga	*	—	—	—
— *Diotrepha*	*	—	*	—
Epiphragma–Epiphragma	*	*	—	—
Polymera–Polymera	*	—	—	*
Shannonomyia	*	—	*	*
Atarba–Atarba	*	—	—	—
Hexatoma–Eriocera	*	*	*	*
Elephantomyia–Elephantomyia	*	*	—	—
Gonomyia–Gonomyia	*	—	—	—
— *Progonomyia*	*	—	*	—
— *Ptilostena*	*	—	—	—
— *Lipophleps*	*	*	*	*
Teucholabis–Teucholabis	*	—	*	—
Trentepohlia–Paramongoma	—	—	*	*
Rhabdomastix–Sacandaga	—	*	*	—
Erioptera–Empeda	—	—	*	—
— *Mesocyphona*	*	—	—	*
Toxorhina–Toxorhina	*	*	—	*

From this list, it will be seen that of the 30 groups, Cuba has 27, Jamaica 17, Puerto Rico 16 and Hispaniola 12. The marked deficiency in the case of the last-named major island is surely a result of collecting rather than an actual condition. The non-occurrence

of such conspicuous elements as *Brachypremna* and *Megistocera* in Jamaica is noteworthy.

Of the above, the sole endemic group is the subgenus *Megistomastix,* known only from two species, one being confined to Puerto Rico, the other to western Cuba. This subgenus finds its near ally in the subgenus *Oropeza* Needham, widely distributed in eastern North America, and must surely have been derived from the north. The two species of *Nephrotoma* (*ferruginea* Fabr., var.) and *Tipula* (*ludoviciana* Alex.) in Cuba are forms that also occur in the southeastern United States, and have certainly invaded the island from the north. Of the Limoniinae in the islands, *Discobola, Sacandaga, Gonomyia* s.s. and *Ptilostena* are evidently derived from the north.

Megistocera, Brachypremna, Neolimnobia, Rhipidia, Geranomyia, Helius, Orimarga s.s., *Diotrepha, Polymera, Atarba, Progonomyia, Lipophleps, Teucholabis, Trentepohlia, Mesocyphona* and *Toxorhina,* on the other hand, all seem to be derivatives from the south, in all cases either having the greater part of their present distribution in Central or South America, or, in the case of larger groups, having the great majority of the known species, insofar as they exist in the New World, occurring in the Neotropics. The origin of some of the other groups, as *Limonia,* s.s., *Dicranomyia, Eriocera,* and possibly a few others, is uncertain, as the groups in question are virtually cosmopolitan. *Limonia* s.s., however, is evidently still another Neotropical element, insofar as it is represented in the Antilles by members of the *apicata* group (*basistylata* Alex., *hoffmani* Alex.), members of which have extended their range northward of the islands into Florida. Some of the species of *Dicranomyia* are northern forms that are isolated at higher altitudes on the mountains of Puerto Rico and Hispaniola (as *divisa* Alex.) or else are widespread coastal forms with a vast range in tropical and subtropical America (as *distans* O. S.). The Cuban *reticulata,* however, is a member of a group of characteristic Neotropical species of the subgenus. The 8 species of *Eriocera* in the Greater Antilles form a highly characteristic group that are more nearly related to species in Middle and South America than they are to the more sombre species of the North.

III. Keys to the Subfamilies, Tribes, Subtribes, Genera and Subgenera of Tipulidae Known From the Greater Antilles

1. Terminal segment of maxillary palpus elongate, whiplash-like; nasus usually distinct; antennae usually with 13 segments; wings with Sc_1 usually atrophied; vein Cu_1 constricted at *m-cu,* the latter usually at

or close to fork of M_{3+4} (Figs. 1–3); body-size usually large. (TIPULINAE) ---------- 2

Terminal segment of maxillary palpus short; no distinct nasus; antennae usually with 14 or 16 segments; wings with Sc_1 present; vein Cu_1 straight, not constricted at *m-cu*, the latter placed far before the fork of M_{3+4}, usually at or close to fork of M (Figs. 4–5, 10–19), in *Orimarga* (Fig. 9) far before the fork of M; body-size small or medium ---------- (LIMONIINAE) ---------- 6

(TIPULINAE)

2. Legs unsually long and filiform; wings with vein R_{1+2} atrophied and with Sc_2 close to origin of *Rs* (*Dolichopeza*, Fig. 3); when R_{1+2} is preserved (*Brachypremna*, Fig. 2, *Megistocera*, Fig. 1), vein *Sc* is very long, Sc_1 reaching *C* as a distinct element some distance beyond the fork of *Rs* and cell *2nd A* is very narrow ---------- 3

Legs of normal stoutness for the family; wings with R_{1+2} preserved and with *Sc* of moderate length, Sc_1 being atrophied before the fork of *Rs* and Sc_2 ending at or before midlength of *Rs*; cell *2nd A* of normal width ---------- 5

3. Antennae 8-segmented; wings with origin of vein M_4 usually opposite or even basad of that of M_{1+2}; R_{2+3} angularly bent at near midlength (Fig. 1) ---------- MEGISTOCERA Wied.

Antennae with 11 or more segments; wings with origin of vein M_4 distad of that of vein M_{1+2}, usually far beyond; R_{2+3} straight or nearly so, not angulated ---------- 4

4. Wings with vein R_{1+2} pale, perpendicular to R_{2+3}; *Rs* elongate, strongly arcuated at origin; cells of wing glabrous (Fig. 2) BRACHYPREMNA O. S.

Wings with vein R_{1+2} atrophied; *Rs* short, transverse, simulating a cross-vein; apical cells with macrotrichia (Fig. 3) ---------- DOLICHOPEZA: MEGISTOMASTIX Alex.

5. Wings with *Rs* short and oblique in position, shorter than *m-cu*; cell M_1 sessile or very short-petiolate; vein M_4 arising opposite or basad of orgin of M_{1+2}; body coloration highly polished, orange and yellow ---------- NEPHROTOMA Meig.

Wings with *Rs* elongate, exceeding *m-cu*; cell M_1 petiolate; vein M_4 arising distad of origin of M_{1+2}; body-coloration gray pruinose (in regional forms) ---------- TIPULA Linn.

(LIMONIINAE)

6. Wings with the free tip of Sc_2 often present; veins R_4 and R_5 fused to margin, only two branches of *Rs* being present; antennae usually with 14 (Limoniaria) or 16 segments. (Limoniinini) ---------- 7

Wings with the free tip of Sc_2 atrophied; veins R_4 and R_5 separate, the former usually transferred to the upper branch, R_{2+3}, to form a distinct element R_{2+3+4}; usually with three branches of *Rs* present (Figs. 10–12, 14, 17–18); in local fauna, exceptions in *Atarba*, *Elephantomyia* (Fig. 13), *Teucholabis* (Fig. 16), some *Gonomyia* (Fig. 15) and *Toxorhina* (Fig. 19), where R_4 is captured by R_{2+3}, as above; antennae usually with 16 segments ---------- 15

7. Wings (Fig. 5) with vein R_2 lacking. (Heliaria)——HELIUS St. Farg.
Wings with vein R_2 present—— 8
8. Wings with *m-cu* three or more times its own length before the fork of *M* (Fig. 9); antennae 16- segmented. (Orimargaria)—— 9
Wings with *m-cu* close to or beyond the fork of *M*, if placed before, the distance not or scarcely exceeding the length of the vein itself (Fig. 4); antennae 14-segmented. (Limoniaria)—— 10
9. Wings with three branches of *M* reaching margin, cell M_3 being present; *m-cu* beneath *Rs*.——ORIMARGA: ORIMARGA O. S.
Wings (Fig. 9) with two branches of *M* reaching margin, cell M_3 being lacking; *m-cu* far before origin of *Rs*.——ORIMARGA: DIOTREPHA O. S.
10. Supernumerary crossveins present in either cell R_3 or *1st A* of wings—— 11
No supernumerary crossveins in either of the cells mentioned—— 12
11. Wings with *Sc* short, Sc_1 ending opposite or before origin of *Rs*; a supernumerary crossvein in cell R_3——LIMONIA: NEOLIMNOBIA Alex.
Wings with *Sc* long, ending about opposite the fork of *Rs*; a supernumerary crossvein in cell *1st A*, connecting the Anal veins near their outer ends——LIMONIA: DISCOBOLA O. S.
12. Mouthparts, and especially the labial palpi, lengthened, the rostrum thus formed much longer than the remainder of head and usually about as long as the combined head and thorax——LIMONIA: GERANOMYIA Hal.
Mouthparts, with the labial palpi, not notably lengthened, shorter than remainder of head—— 13
13. Antennae of male strongly subpectinate, of female less markedly so——
——LIMONIA RHIPIDIA Meig
Antennae simple in both sexes—— 14
14. Wings with *Sc* short, Sc_1 ending opposite or before origin of *Rs*.
——LIMONIA: DICRANOMYIA Steph.
Wings (Fig. 4) with *Sc* long, Sc_1 ending beyond midlength of *Rs*.——
——LIMONIA: LIMONIA Meig.
15. Tibial spurs present. (Hexatomini)—— 16
Tibial spurs lacking. (Eriopterini)—— 22
16. Antennae with not more than 12 segments (Hexatomaria)——
——HEXATOMA: ERIOCERA Macq.
Antennae with more than 14 segments—— 17
17. Wings (Fig. 13) with only two branches of *Rs* present; vein R_2 lacking— 18
Wings (Figs. 10–11, 14) with three branches of *Rs* present; vein R_2 preserved—— 19
18. Rostrum elongate, exceeding one-half the length of remainder of body; wing (Fig. 13). (Elephantomyaria)——ELEPHANTOMYIA O. S.
Rostrum short and inconspicuous, not exceeding the remainder of head. (Atarbaria)——ATARBA O. S.
19. Apical cells of wing with macrotrichia. (Limnophilaria).——
——SHANNONOMYIA Alex., part.
Cells of wing glabrous—— 20
20. A supernumerary crossvein in cell *C* of the handsomely patterned wings (Fig. 14). (Epiphragmaria)——EPIPHRAGMA O. S.

No supernumerary crossvein in cell *C*; wings plain or only sparsely spotted ---- 21

21. Wings (Fig. 10) with cell *1st* M_2 open by atrophy of *m*; cell M_1 present; male with elongate nodulose antennae. (Polymeraria) ---- POLYMERA: POLYMERA Wied.

Wings (Fig. 11) with cell *1st* M_2 closed, in cases where open, cell M_1 lacking; antennae of both sexes short, not nodulose. (Limnophilaria) ---- SHANNONOMYA Alex., part.

22. Rostrum very long and slender, approximately one-half the entire body or longer; setae of legs profoundly bifid; wings (Fig. 19) with a single branch of *Rs* reaching margin. (Toxorhinaria) ---- TOXORHINA: TOXORHINA Lw.

Rostrum short, not exceeding the remainder of head; setae of legs simple; wings with two or three branches of *Rs* reaching margin (Figs. 15–18) ---- 23

23. Two branches of *Rs* reach the wing-margin (Figs. 15–16). (Gonomyaria) 24

Three branches of *Rs* reach the wing-margin (Figs. 17–18) ---- 25

24. Wings (Fig. 16) with R_2 present, close to fork of *Rs*; *Sc* usually long, Sc_1 ending beyond origin of *Rs*. ---- TEUCHOLABIS: TEUCHOLABIS O. S.

Wings (Fig. 15) with R_2 lacking; *Sc* short, Sc_1 ending opposite or before origin of *Rs*. ---- GONOMYIA: LIPOPHLEPS Bergr.

25. Wings (Fig. 17) with vein R_5 fused with M_{1+2} to form the entire cephalic face of cell *1st* M_2, *r-m* thus obliterated; only two branches of *M* reach the margin; vein *2nd A* very short. (Trentepohliaria) ---- TRENTEPOHLIA: PARAMONGOMA Brun.

Wings (Fig. 18) with vein R_5 entirely distinct from M_{1+2}, being separated by the *r-m* crossvein; three branches of *M* reach the margin; vein *2nd A* of normal length ---- 26

26. Wings with cell R_3 short, vein R_3 being shorter than the petiole of cell R_3 ---- 27

Wings (Fig. 18) with cell R_3 deep, vein R_3 longer than the petiole of cell R_3, shortest in *Progonomyia* ---- 30

27. Wings with vein R_2 lacking ---- 28

Wings with vein R_2 present. (Eriopteraria) ---- ERIOPTERA: EMPEDA O. S.

28. Wings with *Sc* long, Sc_1 extending to about opposite or beyond midlength of *Rs*; *m-cu* at or beyond the fork of *M*; trochanters elongate. (Eriopteraria) ---- RHABDOMASTIX: SACANDAGA Alex.

Wings with *Sc* short, not extending to beyond midlength of *Rs*; if *Sc* is relatively long (*Ptilostena*), *m-cu* lies more than its own length before the fork of *M*; trochanters short. (Gonomyaria) ---- 29

29. Wings with *m-cu* more than its own length before fork of *M*. ---- GONOMYIA: PTILOSTENA Bergr.

Wings with *m-cu* at or very close to fork of *M*. ---- GONOMYIA: GONOMYIA Meig.

30. Wings with veins R_2 and R_4 divergent, unequal in length, R_2 being about one-half of R_4; cell R_3 at margin some three or four times as wide as cell R_2. (Gonomyaria) ---- GONOMYIA: PROGONOMYIA Alex.

Wings (Fig. 18) with veins R_2 and R_4 nearly equal in length, or with R_2 exceeding three-fourths the length of R_4, the veins extending generally parallel to one another to the wing-margin; cell R_2 at margin wider than cell R_3. (Eriopteraria) ---- ERIOPTERA: MESOCYPHONA O. S.

IV. A Record of the Tipulidae Known From Puerto Rico, With Keys and Brief Diagnoses of the Species

Subfamily Tipulinae

Megistocera longipennis (Macq.) (Fig. 1)

1838. *Tipula longipennis* Macq.; Dipt. exot., 1, pt. 1: 57, pl. 5, fig. 1.
1885. *Tipula tenuis* van der Wulp; Notes Leyden Mus., 7: 7; Tijdsch. voor Ent., 23: 85, pl. 4, fig. 7.

Frontal prolongation of head brown, the nasus distinct; palpi black. Antennae 8-segmented, short in both sexes; scape and pedicel yellow, flagellum black; first flagellar segment shorter than the second, the remainder gradually decreasing in length outwardly. Head brownish gray, the anterior vertex and front more yellowish; eyes very large, on dorsum separated by the narrow anterior vertex that is only about one-third wider than the diameter of the scape; on ventral surface of head the eyes are broadly holoptic.

Mesonotal praescutum chiefly covered by four confluent light brown stripes, the lateral pair somewhat darker brown; lateral margins of praescutum broadly buffy. Pleura buffy-yellow, vaguely marked on anepisternum and coxae by grayish brown areas. Legs long and filiform, brown, the tarsi deepening to brownish black. Wings (Fig. 1) whitish subhyaline, highly iridescent; stigma dark brown. Venation: Vein M_4 usually arising opposite or basad of origin of M_{1+2}; R_{2+3} angularly bent at proximal end of stigma. Abdomen dark brown, the tergites variegated sublaterally with obscure yellow areas.

Male.—Length about 11–13 mm.; wing 15–17 mm.

Female.—Length about 14–17 mm.; wing 16–19 mm.

One of the two largest Tipulidae in the Greater Antilles, the other being *Brachypremna unicolor* O. S. The venation readily suffices to distinguish the present fly from all others. The head and thorax of the single American species are nearly glabrous whereas in the males of the two Old World forms, the body is provided with a dense pale vestiture. Furthermore, the antennae of both Old World species are enormously lengthened, whereas the organ is short in both sexes of the present fly.

Ranges from northern Florida, southward through the Antilles and on the mainland into Brazil and Paraguay.

Puerto Rico: Recorded by von Röder (Stett. Ent. Zeitg., 1885: 338, as *Tipula*).

Brachypremna unicolor O. S. (Fig. 2)

1887. *Brachypremna unicolor* O. S.; Berlin. Ent. Zeitschr., 31: 239–240.
1912. *Brachypremna unicolor* Alex.; Journ. N. Y. Ent. Soc., 20: 235–236, pl. 16, fig. c (wing).

Mesonotal praescutum light brown, with narrow, more or less interrupted

blackish stripes, the usual three stripes being represented only by marginal darkenings; each lateral stripe double, the median vitta triple by a dark capillary median line. Pleura pale. Legs with the femora yellow, the tips narrowly dark brown; remainder of legs brown, the tarsi brownish black. Wings (Fig. 2) unusually long and narrow, subhyaline, the small stigma dark brown; apex of wing and vague seams along certain of the longitudinal veins brown. Venation: The species differs from all other members of the genus in having both veins $R_2 + _3$ and $R_4 + _5$ arise directly from the end of *Rs*, obliterating the basal section of the latter; cell *1st* M_2 unusually short, roughly triangular in outline; *m-cu* in alignment with the basal section of $M_1 + _2$.

Abdominal tergites dark brown, the bases and lateral portions of the individual segments somewhat paler; sternites pale, with an almost continuous median line of black dashes.

Male.—Length about 12—17 mm.; wing 16—22.5 mm.

Female.—Length about 16—19 mm.; wing 18—21 mm.

This conspicuous crane-fly is widespread throughout the Greater Antilles, elsewhere being recorded only from the island of Grenada, Lesser Antilles.

Puerto Rico: Described from the island, based on three male specimens taken by Moritz. I have no other records from Puerto Rico, although the species is commonly taken in Cuba and Hispaniola.

It might be expected that *Brachypremna dispellens* (Walk.), the commonest and most widely distributed member of the genus, would occur in the Greater Antilles, since it ranges from the Carolinian zone of the eastern United States, southward on the continent to Argentina, occurring on the island of Trinidad but nowhere else in the West Indian islands.

The present fly may be readily told from all other North American members of the genus by the long, very narrow wings that have the peculiar venation above described, and by the unvariegated legs.

Dolichopeza (Megistomastix) portoricensis (Alex.) (Fig. 3)

1912. *Megistomastix portoricensis* Alex.; Psyche, 19: 63–66, pl. 5.
1931. *Dolichopeza* (*Megistomastix*); Alexander, Philippine Journ. Sci., 46: 270.

Antennae (♂) very long, almost twice the length of the entire body. General coloration of body light brown, the thoracic pleura paler. Legs brown. Wings (Fig. 3) light grayish brown, with a darker stigmal area; conspicuous macrotrichia in cells of wing beyond level of cord (indicated in figure by dots).

Male.—Length about 5 mm.; wing 7.5 mm.; antenna about 9.5 mm.

The present fly is the smallest Tipuline species in the island. It is readily told by the apically hairy wings, with a peculiar venation, and by the greatly elongated antennae of the male sex.

Endemic in Puerto Rico. Known only from the mountainous country of the Luquillo National Forest. Type, a ♂, El Yunque, altitude 2800 ft., February 20, 1900 (C. W. Richmond). Type-locality, a ♂ November 18, 1925 (Am. Mus. Nat. Hist., No. F 5113 A).

(Besides the three Tipuline genera above recorded from Puerto Rico, two other genera, *Nephrotoma* and *Tipula,* have been taken elsewhere in the Greater Antilles.)

Subfamily Limoniinae

Tribe Limoniini

Subtribe Limoniaria

The only included genus in this subtribe is *Limonia* Meigen, which is now held to include approximately a score of subgeneric groups that until comparatively recently were considered to be valid genera (as, for example, *Limonia, Discobola, Dicranomyia, Rhipidia* and *Geranomyia,* in the local fauna). For a detailed discussion of the reasons for relegating these groups to a minor status, a paper by the present writer may be consulted (Alexander, Philippine Journ. Sci., 40: 239–248; 1929).

Subgenus **Limonia** Meig.

Limonia (Limonia) hoffmani Alex. (Figs. 4, 6)

1927. *Limonia hoffmani* Alex.; Journ. N. Y. Ent. Soc., 35: 265–266.

General coloration obscure brownish yellow, the praescutum with three dark brown stripes. Antennae black; flagellar segments oval, with short apical pedicels. Legs dark brown, the tips of the femora narrowly obscure yellow. Wings (Fig. 4) with a faint dusky tinge, the oval stigma darker brown. Male hypopygium (Fig. 6) with the single dististyle elongate, attached near midlength, its outer lobe obtuse, setiferous, the inner lobe a long slender point, gradually narrowed to the acute tip.

Male.—Length about 4.5—6 mm.; wing 4.5—5.5 mm.

Female.—Length about 5—6 mm.; wing 5—5.5 mm.

Endemic in Puerto Rico. Type, a ♂, Luquillo National Forest, May 10–13, 1927 (W. A. Hoffman). 1 ♂, El Yunque, 1800 feet, February 11, 1930 (M. D. Leonard). 1 ♂, Las Cruces, 1300 feet, March 28, 1930 (M. D. Leonard). 1 ♀, Yauco–Lares, in mountains, resting on coffee leaves (Seín and Wolcott).

The closest ally is another Antillean species, *L.* (*L.*) *basistylata* Alex., of Jamaica.

(The subgenus *Discobola* is not found in Puerto Rico. A new species, *Limonia* (*Discobola*) *gowdeyi*, from Cuba and Jamaica, is described later in the present report).

Subgenus **Neolimnobia** Alex.

Limonia (Neolimnobia) diva (Schin.)

1868. *Limnobia diva* Schin.; Novara Reise, Dipt., p. 46.

1928. *Dicranomyia* (*Neolimnobia*) *diva* Alex.; Dept. Sci. and Agr. Jamaica, Ent. Bull. 4. Catalogus Insectorum Jamaicensis, pt. 3: 20–21.

1929. *Limonia* (*Neolimnobia*) *diva* Alex.; Philippine Journ. Sci., 40: 239–244.

Rostrum and palpi black. Antennae chiefly dark brown; incisures of the flagellar segments restrictedly pale. Head velvety-black in front, paler on the posterior genae.

Mesonotal praescutum with the ground-color blackish, the three usual stripes more brownish yellow, the median one becoming blackish on its posterior half; scutellum and median region of scutum yellow pollinose; scutal lobes extensively brownish black on mesal portion; cephalic portion of postnotal mediotergite broadly blackened medially. Pleura chiefly yellow pollinose. Halteres yellow. Femora yellow, handsomely banded with brownish black; fore and middle femora with two brown rings, posterior femora with three such rings; remainder of legs obscure orange. Wings pale yellow, more saturated yellow on prearcular and costal regions, with an abundant reticulate or muscoid pale brown pattern, appearing as transversely parallel zigzag lines in most of the cells, more approximated and subconfluent to form broken bands before the level of origin of *Rs* and along the cord; veins yellow. Venation: A supernumerary crossvein in cell R_3.

Male.—Length about 6—8 mm.; wing 8—10 mm.

Widely distributed throughout the Greater Antilles, in the mountains. Elsewhere widespread in northern South America, in Central America and Mexico.

Puerto Rico: El Yunque, Luquillo National Forest, altitude 1800 feet, February 11, 1930 (M. D. Leonard).

The peculiar banding of the femora and the reticulate wings with a supernumerary crossvein in cell R_3, serve to define the present species. The fly bears a curious superficial resemblance to some species of the Hexatomine genus *Epiphragma*. The relationships existing between *diva* and some other allied Neotropical members of the subgenus have been discussed in the Alexander 1928 paper, above cited.

Subgenus **Dicranomyia** Steph.

Of this abundant and widespread group, only three species have been taken in Puerto Rico. Elsewhere in the Antilles a few additional species are found, but the subgenus is by no means as extensive and characteristic as is *Geranomyia.*

A KEY TO THE PUERTO RICAN SPECIES

1. Wings with cell M_2 open by the atrophy of *m*; *Rs* very short, less than *m-cu*; *Sc* short, Sc_1 ending before the origin of *Rs* a distance about equal to the entire length of the latter ..... *brevivena torrida* subsp. n.

   Wings with cell *1st* M_2 closed; *Rs* distinctly longer than *m-cu*; *Sc* longer, Sc_1 ending opposite or only a little before the origin of *Rs* 2

2. General coloration of thorax brown, with a sparse pollinosity; praescutum with three darker stripes ..... *distans* O. S.

   General coloration of thorax yellow, the praescutum without distinct stripes ..... *divisa* Alex.

Limonia (Dicranomyia) brevivena torrida subsp. n.

Close to typical *brevivena* O. S. in venation and hypopygial characters, differing chiefly in the details of body-coloration.

Antennae with the scape light yellow. Head with the rostrum, from and anterior vertex yellow, the posterior vertex brownish gray.

Mesonotum yellow to brownish yellow, the praescutum with three clearly defined dark brown stripes, the median one not reaching the suture behind, the lateral stripes crossing the suture and extending to the abdomen, gradually converging behind to leave the central portions of the scutum, scutellum and postnotal mediotergite narrowly pale. Pleura pale yellow, the ventral sternopleurite restrictedly darkened.

Habitat.—Puerto Rico.

Holotype, alcoholic ♂, Puerto Real, Vieques Is., at light, September 25–27, 1931 (M. D. Leonard). Allotopotype, alcoholic ♀. Paratopotypes, a few alcoholic ♂ ♀.

The thoracic pattern is quite different from that of more northern specimens that seem to be typical of *brevivena,* s.s.

Limonia (Dicranomyia) distans (O. S.) (Fig. 7)

1859. *Dicranomyia distans* O. S.; Proc. Acad. Nat. Sci. Philadelphia, 1859: 211.

1869. *Dicranomyia distans* O. S.; Mon. Dipt. N. Amer., 4: 67–68.

General coloration brown, with a sparse golden-yellow pollen. Mesonotal praescutum with three darker stripes. Flagellar segments nearly globular. Halteres short. Wings with a faint brown tinge, the stigma scarcely indicated; veins brown. Venation: Sc_1 ending about opposite the origin of *Rs*, Sc_2 some

distance from its tip so that Sc_1 alone is nearly equal in length to *m-cu*; cell *1st* M_2 closed.

Male hypopygium (Fig. 7) readily distinguished from all similar forms by the presence of 3, or more rarely 4, straight spines on the rostral prolongation of the ventral dististyle.

Male.—Length about 4.5 mm; wing 4.5—5.5 mm.

Female.—Length about 5.5—6 mm.; wing 5.5—6 mm.

A common species in the southern United States, occurring much farther south on the mainland, reaching its southern limit in Paraguay; Puerto Rico.

Puerto Rico: Puerto Real, Vieques Is., at light, September 25–27, 1931 (M. D. Leonard). Río Piedras, February 1932 (M. D. Leonard).

Limonia (Dicranomyia) divisa Alex. (Fig. 8)

1859. *Dicranomyia diversa* O. S.; Proc. Acad. Nat. Sci. Philadelphia, 1859: 212, name preoccupied.

1929. *Limonia* (*Dicranomyia*) *divisa* Alex.; Philippine Journ. Sci., 40: 247.

General coloration of body yellow. Head darkened. Antennae pale brown, the basal segments paler. Halteres with the knobs darkened. Wings with a faint brownish tinge, the oval stigma slightly darker. Venation: Sc_1 ending shortly before the origin of *Rs*, Sc_2 some distance from its tip, Sc_1 alone subequal to or longer than *m-cu*; cell *1st* M_2 closed. Male hypopygium (Fig. 8) distinctive in structure, the rostral prolongation of the ventral dististyle being deeply and conspicuously bifid at apex, while the basistyle has the ventro-mesal lobe very large and complicated by lobules and groups of rows of setae of various shapes and sizes.

Male.—Length about 3.5—4 mm.; wing 4—4.5 mm.

Eastern North America, recurring in the mountains of Hispaniola and Puerto Rico.

Puerto Rico: El Yunque, 1800 feet, February 11, 1930 (M. D. Leonard). The same, altitude 2000-3500 feet, March 29, 1930 (M. D. Leonard).

Subgenus **Rhipidia** Meig.

Besides the common and widespread *domestica*, discussed below, two other species of *Rhipidia* occur in the Greater Antilles and may be found in Puerto Rico. *L.* (*R.*) *schwarzi* (Alex.) is widely distributed in the southeastern United States and West Indian islands. It is readily told from *domestica* by the numerous brown dots in all cells of wing and by the broad pale yellow border to the mesonotal praescutum. Both of these flies belong to the so-called *domestica*

group, having the antennae of the male merely subpectinate. A second regional species, *L.* (*R.*) *subcostalis* (Alex.) is known from Jamaica and Central America. This fly belongs to a very different group of *Rhipidia* and may readily be distinguished by the conspicuous pale yellow posterior tarsi. For a more detailed account, consult a paper by the writer (The Crane-flies of Jamaica. Dept. Sci. and Agr. Jamaica, Ent. Bull. 4:19–29; 1928).

Limonia (Rhipidia) domestica (O. S.)

1859. *Rhipidia domestica* O. S.; Proc. Acad. Nat. Sci. Philadelphia, 1859; 208.

1869. *Rhipidia domestica* O. S.; Mon. Dipt. N. Amer., 4, pl. 3, fig. 5 (male hypopygium).

1912. *Rhipidia domestica* Alex.; Bull. Brooklyn Ent. Soc., 8:15–16, pl. 1, fig. g (wing).

1919. *Rhipidia domestica* Alex.; Crane-flies of New York, part 1, pl. 32, fig. 40 (wing).

Antennae subpectinate, appearing moniliform; segments black, with the penultimate and antepenultimate (12th and 13th) segments abruptly pale yellow. Head dark gray.

Mesonotal praescutum with the stripes dark brown, the interspaces with a golden-yellow pollen. Legs obscure yellow, the tips of the femora and tibiae weakly darkened. Wings subhyaline, the centers of most of the cells streaked longitudinally with pale gray; a series of about five darker spots along the costal border of wing; stigmal area ring-like, with a pale center. Venation: *Sc*, ending just before midlength of *Rs*; *m-cu* some distance before the fork of *M*, in cases the distance exceeding *m-cu* itself.

Male.—Length about 4.5—6 mm.; wing 5.5.—7 mm.
Female.—Length about 6—6.5 mm.; wing 6—7 mm.

Widely distributed throughout the southern United States, from the Carolinian zone southward throughout the Antilles and on the continent to Argentina.

Puerto Rico: Manatí, June 27–29, 1915 (A.M.N.H.). Santurce, April 4, 1930 (M. D. Leonard). Río Piedras, March 12, 1930 (M. D. Leonard). Coamo Springs Hotel, at light, April 4, 1930 (M. D. Leonard). Puerto Real, Vieques Is., at light, September 25–27, 1931 (M. D. Leonard).

The fly is readily told by the coloration of the antennae, the two subterminal segments being pale yellow, contrasting abruptly with the blackened remainder of the organ. *L.* (*R.*) *schwarzi* has a somewhat similar antennal pattern, but is readily distinguished by the coloration of the wings and thorax, as described above.

Subgenus **Geranomyia** Hal.

Rather numerous species of *Geranomyia* occur in Puerto Rico. In addition to these forms, which are keyed and discussed below, a few other species are known from the other Antillean islands and may be found in Puerto Rico. Elsewere in the Neotropics, the subgenus is represented by a host of species.

The larvae of the known species are chiefly members of the hygropetric associations found on the wet faces of cliffs, at margins of streams and in similar places. The adults suck the nectar of various flowers by means of their long conspicuous beaks. The only other crane-flies in the fauna with elongate rostra are *Elephantomyia* and *Toxorhina,* in which the entire frontal region of the head is drawn out into a filiform structure, with the reduced mouthparts at the extreme tip. In *Geranomyia,* however, several structures take part in the formation of the rostrum, the longest and most conspicuous elements being the paired labial palpi.

A KEY TO THE PUERTO RICAN SPECIES

1. Wings unmarked, except for the stigmal spot when this is present 2
   Wings with a restricted dark pattern, in addition to the stigmal area 6
2. *Sc*$_2$ ending opposite the origin of *Rs* 3
   Sc$_1$ ending distinctly beyond the origin of *Rs,* about opposite one-fifth to one-third the length of the vein 5
3. Fore tibiae with the tips blackened and slightly enlarged 4
   Fore tibiae not blackened or enlarged at tips ..... *rufescens* (Lw.)
4. Male hypopygium with the spines of the rostral prolongation of the ventral dististyle exceeding twice the length of the prolongation alone; gonapophyses with the mesal-apical lobe distinctly bidentate at apex ..... *tibialis* (Lw.)
   Male hypopygium with the spines of the rostral prolongation of the ventral dististyle shorter, a little longer than the prolongation itself; gonapophyses with merely a lateral flange on the mesal-apical lobe ..... *myersiana* Alex.
5. General coloration gray, the praescutum with a median blackish stripe; rostrum short, approximately one-third the length of the body ..... *cinereinota* (Alex.)
   General coloration in life pale green, paling to yellow or greenish yellow in dead specimens; rostrum elongate, exceeding one-half the length of the body ..... *virescens* (Lw.)
6. Wings with a very restricted dark pattern; apex of wings beyond level of stigma and tips of the Anal veins without dark markings; fore tibiae not darkened at tips ..... *subrecisa* sp. n.
   Wings with the dark pattern more extensive, including clouds in the apical cells and at ends of both Anal veins; fore tibiae conspicuously blackened and enlarged at tips ..... *antillarum* Alex.

Limonia (Geranomyia) antillarum Alex.

1929. *Limonia* (*Geranomyia*) *antillarum* Alex.; Journ. N. Y. Ent. Soc., 37: 395–396.

Mesonotal praescutum with four brownish gray to gray stripes, the lateral pair usually clearer gray than the intermediates, the interspaces brown to black. Pleura buffy-gray, variegated with dark brown. Legs with the femora yellow, with a broad brown subterminal ring; tips of tibiae darkened, especially the fore tibiae which are slightly swollen and blackened. Wings with a restricted dark brown pattern; area over origin of *Rs* narrow, oblique, its proximal end lying over end of vein *Sc*; stigmal area shallow, its posterior edge not or but slightly passing caudad of vein R_2+_3. Abdomen brown, the caudal margins of the segments narrowly pale.

Male.—Length, excluding rostrum, about 7—7.5 mm.; wing 7.5—8 mm.; rostrum about 3 mm.

Female.—Length, excluding rostrum, about 8—9 mm.; wing 7.3—8 mm.; rostrum about 3.2—4 mm.

Known from all four major islands of the Greater Antilles.

Puerto Rico: Coamo Springs Hotel, at light, April 4, 1930 (M. D. Leonard); the same, April 10, 1930 (W. T. M. Forbes).

This species is allied to and has been confused with the more northern *L.* (*G.*) *rostrata* (Say). From this latter species, it differs especially in its larger size, subterminal darkened rings on femora, narrower wings, with a slightly different pattern, and in the details of the male hypopygium.

Limonia (Geranomyia) cinereinota (Alex.)

1913. *Geranomyia cinereinota* Alex.; Ent. News, 24: 407–408, pl. 14, fig. 4 (wing).

1916. *Geranomyia domingensis* Alex.; Proc. Acad. Nat. Sci. Philadelphia, 1916: 490–491.

Rostrum short, as shown by the measurement. Head black, enclosing a silvery triangle. Mesonotal praescutum gray, with a broad blackish median line. Legs with the femora obscure yellow; tibiae and tarsi passing to brown. Wings nearly hyaline, the stigma small and relatively indistinct. Venation: Sc_1 ending about opposite one-fourth the length of *Rs*. Male hypopygium with the lateral lobes of the ninth tergite conspicuously setiferous. Rostral prolongation of the ventral dististyle elongate, the two rostral spines placed at and before midlength, separated from one another by a distance about equal to the basal tubercle of one; spines unequal, the outer about one-third to one-half longer than the inner spine.

Male.—Length, excluding rostrum, about 5—5.5 mm.; wing 6.5—7 mm.; rostrum about 1.8 mm.

Female.—Length, excluding rostrum, about 5.5—6 mm.; wing 5.5—7 mm.; rostrum about 1.6 mm.

Northern South America, northward in the Antilles to Puerto Rico and Hispaniola.

Puerto Rico: Mameyes, November 19, 1925 (A.M.N.H. No. F 5114 A). Río Piedras, March 12, 1930 (M. D. Leonard). Luquillo National Forest, May 10–13, 1927 (W. A. Hoffman). El Yunque, Luquillo, altitude 1800 feet, February 11, 1930 (M. D. Leonard).

Limonia (Geranomyia) myersiana Alex.

1929. *Limonia (Geranomyia) myersiana* Alex.; Journ. N. Y. Ent. Soc., 37: 397–398.

General coloration pale brown. Mesonotal praescutum with three narrow pale brown stripes. Tips of fore tibiae conspicuously blackened. Wings faintly tinged, unmarked except for the oval, pale brown stigma. Venation: *Sc* short, Sc_1 ending opposite or shortly before origin of *Rs*. Male hypopygium with the mesal-apical lobe of the gonapophyses slender, gently curved, the outer edge bearing a small flange. Dorsal dististyle considerably longer than in *tibialis*.

Male.—Length, excluding rostrum, about 4—4.5 mm.; wing 5.3—6 mm.; rostrum about 2.3—2.7 mm.

Known only from Cuba and Puerto Rico.

Puerto Rico: El Yunque, Luquillo National Forest, altitude 1800 feet, February 11, 1930 (M. D. Leonard).

Allied to *L.* (*G.*) *tibialis* (Lw.), yet well-distinguished by the structure of the male hypopygium.

Limonia (Geranomyia) rufescens (Lw.)

1851. *Aporosa rufescens* Lw.; Linn. Ent., 5: 396–397, figs. 9–12.

General coloration of body reddish yellow, more intense on the thoracic dorsum. Mesonotal praescutum with three brownish black longitudinal stripes, the median one broader. Knobs of halteres infuscated. Tips of femora and tibiae slightly darkened, but the fore tibiae not enlarged or blackened at tips. Wings with a grayish brown suffusion; stigma large, brown.

Female.—Length, excluding rostrum, about 5 mm.

Known only from Puerto Rico: Loew's original type, collected by Moritz.

There is great uncertainty as to the identity of this species. Lowe's description and figures indicate that the fore tibiae are not blackened at tips, otherwise the fly is almost exactly like what we have identified as *L.* (*G.*) *tibialis* (Lw.). The only fly that answers the description given by Loew that has been discovered in the Antilles is *tibialis* and it is possible that the two species are identical. However, since Loew distinctly figures *rufescens* as having the fore legs present in his type, it seems advisable for the present to retain *rufescens* as being distinct from *tibialis*.

Limonia (Geranomyia) subrecisa sp. n.

Allied to *recisa;* general coloration of mesonotum light brown, with a pale yellow central stripe that is further split on praescutum by a median brown vitta; femora with a narrow pale brown subterminal ring; wings with a very restricted dark pattern; Sc_1 ending opposite origin of *Rs;* a supernumerary crossvein in cell *Sc;* male hypopygium with the rostral spines arising from small to scarcely evident tubercles; gonapophyses with the mesal apical lobes wider than in *recisa.*

Male.—Length, excluding rostrum, about 5 mm.; wing 5.3 mm.; rostrum about 1.8 mm.

Female.—Length, excluding rostrum, about 6 mm.; wing 5.5 mm.; rostrum about 2 mm.

Described from alcoholic specimens.

Rostrum relatively short, dark brown, the extreme tips of the labial palpi pale. Antennae brown throughout; flagellar segments oval. Head dark gray, with a narrow silvery line.

Pronotum brown. Mesonotum light brown, traversed by a pale yellow central vitta extending the entire length of the notum, wider on the praescutum and here enclosing a darker brown median vitta; on posterior sclerites the pale central vitta is narrowly margined with darker. Pleura chiefly testaceous brown. Halteres pale, the knobs infuscated. Legs with the coxae and trochanters yellow; femora yellow, the tips somewhat clearer yellow, preceded by a narrow pale brown ring; tibiae and tarsi brownish yellow. Wings grayish subhyaline, with a very restricted brown pattern, the most evident areas being three in number, including the stigma and small clouds at the supernumerary crossvein in cell *Sc* and over the origin of *Rs* and tip of *Sc*; cord very vaguely seamed with brown; veins brown. Venation: Sc_1 ending opposite origin of *Rs*, Sc_2 at its tip; a supernumerary crossvein just beyond midlength of cell *Sc*; *m-cu* close to fork of *M*; cell *2nd A* narrow.

Abdomen brownish yellow, variegated by darker brown, the latter chiefly on the lateral and caudal portions. Male hypopygium with the caudal margin of tergite strongly emarginate, the lobes with strong setae. Basistyle relatively small, the ventro-mesal lobe large. Dorsal dististyle a gently curved rod, its apex suddenly narrowed to a point. Ventral dististyle large and fleshy; rostral prolongation slender, the two slender rostral spines placed close together near base of prolongation which they exceed in length; spines arising from very small, scarcely evident tubercles. Gonapophyses with the mesal apical lobe wider than in *recisa.*

Habitat.—Puerto Rico.

Holotype, alcoholic ♂, Puerto Real, Vieques Is., at light, September 25–27, 1931 (M. D. Leonard). Allotopotype, alcoholic ♀.

Limonia (Geranomyia) subrecisa is most nearly allied to *L. (G.) recisa* Alex. (Mexico–El Salvador) in the short *Sc*, in conjunction with the wing-pattern and general structure of the male hypopygium.

It differs most decisively in the narrow cell *2nd A* of the wings and in genitalic structures, as the reduced basal tubercles of the rostral spines of the ventral dististyle and in the broader apical lobes of the gonapophyses.

Limonia (Geranomyia) tibialis (Lw.)

1851. *Aporosa tibialis* Lw.; Linn. Ent., 5: 397–398.

Rostrum long, black. General coloration of mesonotum light brownish yellow, the praescutum with three narrow but distinct dark brown stripes, the median stripe longest, narrowed behind. Legs chiefly obscure yellow, the tips of the femora weakly infumed; tips of tibiae narrowly darkened, of the fore tibiae slightly swollen and intensely blackened. Wings with a sandy suffusion, the stigma a little darker. Venation: Sc_1 ending opposite origin of *Rs*, Sc_2 at its tip. Male hypopygium with the rostral spines of the ventral dististyle long and straight, divergent, each arising from a small basal tubercle. Gonapophyses bifid at apices.

Male.—Length, excluding rostrum, about 4.5—5 mm.; wing 5—5.5 mm.; rostrum about 2.8—3 mm.

Female.—Length, excluding rostrum, about 5.5—6 mm.; wing 5.5—6 mm.; rostrum about 3—3.5 mm.

Originally described from Brazil, now known to have a vast range in the Neotropics.

Puerto Rico: Puerto Real, Vieques Is., at light, September 25–27, 1931 (M. D. Leonard).

Limonia (Geranomyia) virescens (Lw.)

1851. *Aporosa virescens* Lw.; Linn. Ent., 5: 398.

General coloration of entire insect pale green, fading in death to yellow, but usually with persistent green tints on some parts of body. Antennae black; flagellar segments subglobular. Mesonotum without markings. Wings nearly hyaline, the stigma pale brown. Venation: Sc_1 ending some distance beyond origin of *Rs*.

Male.—Length, excluding rostrum, about 4 mm.; wing about 5 mm.; rostrum about 2.8 mm.

Described from the island of St. Thomas, Virgin Island, collected by Moritz. The reference of the Puerto Rican specimens to *virescens* is rendered somewhat doubtful because of inability to study the detail of structure of the male hypopygium of the type. A small number of allied species of small green *Geranomyia* are now known from Middle America.

Puerto Rico: Las Cruces, altitude 1300 feet, March 28, 1930 (M. D. Leonard).

Subtribe Heliaria

The only included genus in this subtribe is *Helius* St. Farg., rich in species and occurring in all regions of the World. In the Greater Antilles, two species occur, with one in Puerto Rico.

Helius (Helius) albitarsis (O. S.) (Fig. 5)

1887. *Rhamphidia albitarsis* O. S.; Berlin. Ent. Zeitschr., 31: 184.

General coloration rather dark brown, the pleura paler, more yellowish. Rostrum about one-third longer than the remainder of head, brownish. Antennnae black throughout; verticils considerably longer than the segments. Legs dark brown, the distal half of tarsi white or whitish. Wing (Fig. 5) with a strong blackish tinge, the elongate stigma even darker brown. Venation: Sc_1 ending before termination of *Rs*, Sc_2 *at* its tip; *r-m* very short or obliterated by the fusion of veins R_{4+5} and M_{1+2}; cell *1st* M_2 large, roughly pentagonal or hexagonal in outline, the longest elements being the two sections of M_{1+2}; *m-cu* at near midlength of the cell. Abdomen, including the hypopygium, black.

Male.—Length about 6—7 mm.; wing 6.5—7.5 mm.

Female.—Length about 6.5—8 mm.; wing 6.5—8.5 mm.

The species is widely distributed in Central and northern South America.

Puerto Rico: The type, a ♂, was taken in Puerto Rico by Moritz. Luquillo National Forest, May 10–13, 1927 (W. A. Hoffman).

Helius albitarsis is readily told by the dark coloration of the body and wings, in conjunction with the white feet. In the present fauna, the only other crane-fly having this general size and appearance is *Trentepohlia* (*Paramongoma*) *niveitarsis* (Alex.), a very different fly. The Jamaican *Helius creper* Alex. is well-distinguished from *albitarsis* by the venation, notably the small cell *1st* M_2 and consequent full development of the *r-m* crossvein.

(No representatives of the genus *Orimarga O. S.*, sole American genus in the subtribe Orimargaria, have yet been taken in Puerto Rico. Both the typical subgenus and *Diotrepha* O. S. are found in Cuba and it seems highly probable that *Orimarga* (*Diotrepha*) *mirabilis* (O.S.) will be found to occur in Puerto Rico. It is readily told by the very remarkable venation (Fig. 9), notably the basal position of *m-cu*. The fly is an elongate insect, grayish, with long white legs, the femora with broadly blackened tips, the tibiae more narrowly so. A new Cuban member of the typical subgenus is described later in the present report.)

Tribe Hexatomini

The Hexatomine crane-flies are not strongly represented in the Greater Antilles. In Puerto Rico, three genera occur. Elsewhere

in the islands, a few additional groups are found (*Epiphragma, Atarba, Elephantomyia*). *Epiphragma* includes medium-sized to rather large crane-flies with the wings handsomely banded and variegated with brown and with the femora variously ringed with yellow and dark brown or black (Fig. 14). *Elephantomyia* is readily told by the greatly produced front, the only other local crane-fly with such a type of rostrum being the Eriopterine genus *Toxorhina* which is readily told from all other crane-flies by having a single branch of *Rs* reaching the wing margin (compare *Elephantomyia,* fig. 13 and *Toxorhina,* fig. 19). *Atarba* has many species in the Neotropics and representatives may well be expected to occur in Puerto Rico.

Subtribe Polymeraria

Includes in America only the genus *Polymera* Wied., a large and eminently characteristic genus in the Neotropics, with more than a score of described forms. Two species range northward into the southeastern United States, while two others occur in the Greater Antilles. Of these, only *geniculata* has been taken in Puerto Rico. *Polymera obscura* Macq. has been found in Cuba, thence ranging southward over most of South America.

Polymera (Polymera) geniculata Alex. (Fig. 10)

1915. *Polymera geniculata* Alex.; Insec. Inscit. Menst., 3:106–107.

Flagellar segments of male binodose; brownish black, the second to sixth segments narrowly and indistinctly paler at incisures. Legs brown, the genua pale, the conspicuous pale femoral tip preceded by a darker brown ring; extreme base of tibia similarly pale; tarsi brown, the posterior tarsi of a slightly paler shade than the remaining tarsi. Wings (Fig. 10) with $R_1 + _2$ about twice R_2 alone, basal section of R_5 slightly arcuated, a little longer than *r-m*; *m-cu* just beyond the fork of M; cell M_1 shallow.

Male.—Length about 4 mm.; wing 4.8 mm.; antenna about 7—8 mm.

Known only from Puerto Rico. Type, Carolina, altitude 100 feet, in crab-holes under rocks, September 11, 1914. A second specimen was reared by W. A. Hoffman from a pupa taken February 20, 1927, in an eddy of a rapidly flowing rocky stream at Barranquitas, where it was associated with larvae of a species of *Dixa;* the adult emerged February 21, 1927.

Subtribe Limnophilaria

The vast subtribe Limnophilaria is represented in the Greater Antilles only by several diverse species of *Shannonomyia* Alex.

Genus **Shannonomyia** Alex.

1929. *Shannonomyia* Alex.; Diptera Patagonia and South Chile, 1: 142–143.

The species of *Shannonomyia* are numerously represented in South America. In the Greater Antilles, 6 species have been discovered, there being two each in Cuba, Puerto Rico and Jamaica. No representatives of the genus have yet been taken in Hispaniola but must certainly occur. The Antillean species show some remarkable tendencies of venation, notably the shortening of vein *Sc* and the reduction in size of cell R_3 of the wings. In cases, cell *1st* M_2 is greatly lengthened (as in *leonardi*, fig. 11). In still other species, the cell is open by the atrophy of crossvein *m* (as *myersiana* Alex., *nacrea* Alex., *triangularis* Alex.). The Jamaican *S. myersiana* is very remarkable in the elongate antennae of the male sex and in the presence of macrotrichia in the apical cells of the wing.

A KEY TO THE PUERTO RICAN SPECIES

1. Cell *1st* M_2 of the wings elongate, closed, exceeding the veins beyond it (Fig. 11); wings with a restricted brown spotted pattern___*leonardi* sp. n.
   Cell *1st* M_2 open by the atrophy of *m*; wings unmarked, except for the small stigmal area_____*triangularis* Alex.

Shannonomyia leonardi sp. n. (Fig. 11)

General coloration pale yellow; wings yellow with a restricted dark brown spotted pattern that is confined to the veins and crossveins; *Sc* short, R_2 about one-half R_3+_4, cell R_3 being short; cell *1st* M_2 closed, long and narrow, exceeding any of the veins beyond it.

Male.—Length about 4 mm.; wing 3.8—4 mm.

Female.—Length about 5 mm.; wing 3.5.

Described from alcoholic specimens.

Rostrum yellow; palpi dark brown. Antennae short in both sexes; scape and pedicel yellow; the short, crowded flagellar segments dark brown. Head pale yellow.

Mesonotal praescutum and scutum bright yellow, the remainder of dorsum more whitish yellow; scutellum more or less darkened. Pleura whitish yellow. Halteres pale. Legs with the coxae and trochanters whitish; remainder of legs broken. Wings (Fig. 11) yellow, with a restricted dark brown spotted pattern, as follows: At arculus; origin of *Rs*; Sc_2, the last two elements sometimes confluent; stigma; cord and outer end of cell *1st* M_2; marginal seams on veins R_3, M_1+_2, M_3, M_4, Cu_1 and *2nd A*; veins yellow, brown in the darkened areas. Venation: Prearcular cells extensive; *Sc* unusually short, Sc_1 ending shortly beyond origin of *Rs*, Sc_2 a short distance from its tip; R_2 subequal to R_1+_2; *Rs* of moderate length, angulated and weakly spurred at origin; cell R_3 relatively short, R_2 being about three-fourths of R_2+_4; cell *1st* M_2 long and narrow, exceeding any of the veins beyond it; *m* and basal section of M_3 subequal; *m-cu* beyond fork of *M*; vein *2nd A* curved into *Anal* margin.

Abdomen brownish yellow, the lateral margins narrowly darker; hypopygium pale, only the tips of the outer dististyle blackened.

Habitat.—Puerto Rico.

Holotype, alcoholic ♂, El Yunque, Luquillo National Forest, altitude 1800 feet, February 11, 1930 (M. D. Leonard). Allotopotype, alcoholic ♀. Paratopotype, alcoholic ♂.

I take great pleasure in naming this distinct crane-fly in honor of the collector, Dr. Mortimer D. Leonard. The species is very different from all other described members of the genus, being readily told by the combination of spotted wings, unusually short *Sc* and elongate cell *1st* M_2. The medial field is about as in the Cuban *S. mesophragma* Alex., but the other details of venation are quite different.

Shannonomyia triangularis (Alex.)

1927. *Pilaria triangularis* Alex.; Journ. N. Y. Ent. Soc., 35: 270–271.

General coloration pale brown. Head brownish black, paler anteriorly. Antennae with scape and pedicel obscure yellow; flagellum dark brown. Femora and tibiae very pale brown. Wings grayish subhyaline, the small stigma pale brown. Venation: *Sc* of moderate length, Sc_1 ending between one-third and one-half the length of Rs; cell R_3 small and triangular in outline, somewhat as in species of the Eriopterine subgenus *Gonomyia*; cell *1st* M_2 open by the atrophy of m; m-cu at or only shortly beyond the fork of M. In some specimens, cell R_3 is a little deeper but in all cases originates beyond the level of vein Rs.

Male.—Length about 4.5 mm.; wing 4—4.5 mm.

Female.—Length about 5 mm.; wing 5 mm.

Known only from Puerto Rico and apparently restricted to the mountainous section of the Luquillo National Forest. Type, May 10–13, 1927 (W. A. Hoffman). Also at 1800 feet, February 11 and March 29, 1930 (M. D. Leonard).

Subtribe Hexatomaria

The subtribe includes the single genus *Hexatoma* Latr., now considered as having three subgenera, one of which, *Eriocera* Macq., is found in the Greater Antilles. *Eriocera* is one of the largest and most characteristic groups of crane-flies in the World, with approximately 200 described species of large and usually showy flies. These are most characteristic of the tropics of both hemispheres. In the Antilles, eight species have now been discovered, forming a somewhat peculiar group. These species are found in all four of the major islands but no one species occurs in more than a single island.

It is very probable that several additional species will be discovered as a result of future collecting.

The early stages of *Eriocera* are aquatic or nearly so, the large carnivorous larvae going to dryer land to pupate. The adults sometimes occur in large swarms, usually close to large streams or rivers.

A KEY TO THE PUERTO RICAN SPECIES

1. Wings with three darkened bands, the first at the wing-root, the second at origin of *Rs*, extending across the wing and being connected with the basal band in the Anal cells; wing-apex chiefly dark, with the centers of cells R_4, R_5, *2nd* M_2 and M_3 grayish-hyaline; thorax yellowish with a grayish blue pruinosity, especially on the pleura and coxae; abdomen with blackish bands on anterior margins of the segments, the incisures yellowish ..... *trifasciata* (Röder)

Wings with an interrupted brown pattern that is ocelliform at the origin of *Rs*; thorax light orange, unmarked; abdomen without blackish bands on the segments, the terminal two segments uniformly blackened ..... *ocellifera* Alex.

Hexatoma (Eriocera) ocellifera (Alex.)

1915. *Eriocera ocellifera* Alex.; Insec. Inscit. Menst., 3: 104–105.

Antennae pale. Head dark. Thorax entirely clear light orange. Femora dull yellow, their apices narrowly dark brown; tibiae and tarsi black. Wings light yellow, with cell *C* dark brown; an interrupted narrow dark band along cord; an ocelliform darkening centering at origin of *Rs*; wing-tip narrowly margined with brown. Venation: Cell M_1 lacking; R_{2+3} about one-half longer than R_2. Abdomen orange, the terminal two segments blackened.

Male.—Length about 10.5 mm.; wing 9.8 mm.

Known only from the unique type, taken at Mayagüez, December 4, 1913, by R. H. Van Zwaluwenburg, now in the U. S. National Museum.

Hexatoma (Eriocera) trifasciata (Röder)

1885. *Eriocera trifasciata* Röder; Stett, Ent. Zeitig., 46 338.

The detailed diagnosis given in the above key includes about all that is known of this fly.

Like the last, is is known from the unique type only, this having been taken in Puerto Rico by Gundlach, who reports the species as being rare.

The venation of the closely allied *H.* (*E.*) *cubensis* (Alex.) is shown (Fig. 12).

Tribe ERIOPTERINI

Several genera and subgenera of this great tribe are found in the Greater Antilles, the most abundant and characteristic groups

being *Gonomyia, Teucholabis* and *Erioptera.* The small species of the subgenus *Lipophleps* (*Gonomyia*) are especially well-represented in Puerto Rico.

Subtribe Gonomyaria

This includes only *Gonomyia* and *Teucholabis* in the Antilles. Of these, only *Gonomyia,* with a single subgenus *Lipophleps* Bergr., is found in Puerto Rico. *Lipophleps* is a very extensive group, with approximately 100 described species, distributed in all regions of the World but especially characteristic of the American tropics. Members of this group are often swept from rank vegetation near water. The adults, especially the females, are commonly attracted to lights in the evening and may be found in houses the following day.

A KEY TO THE PUERTO RICAN SPECIES

(Based especially on male genitalic characters)

1. Wings with cell M_2 open by the atrophy of the basal section of M_3; costal border conspicuously whitened; tibiae china-white, tipped with dark brown (*cinerea* group) ..... *helophila* Alex.
   Wings with cell *1st* M_2 closed; costal border yellow or brown, not whitened; legs without white coloration 2
2. Wings with the stigmal spot dark brown, contrasting strongly with remainder of wing; male hypopygium with the apex of basistyle produced into a slender black spine. (*pleuralis* group) ..... *pleuralis* (Will.)
   Wings with the stigma lacking or scarcely evident against the ground-color; male hypopygium with apex of basistyle without any spinous developments. (*manca* group) 3
3. Male hypopygium with a single, entirely fleshy dististyle that is terminal in position; elements of phallosome two in number very long and slender, jutting caudad beyond level of end of dististyle (Fig. 21) ..... *bifiligera* sp. n.
   Male hypopygium with the dististyle subterminal in position, the outer lobe of basistyle being more or less produced caudad into a pale fleshy lobe; elements of phallosome not conspicuously produced (Figs. 22–24) 4
4. Male hypopygium with the dististyle not blackened, fleshy, on outer margin near base bearing a small pale triangular point; outer lobe of basistyle subequal in length and general appearance to the dististyle (Fig. 24) ..... *subterminalis* Alex.
   Male hypopygium with the outer dististyle a strongly curved hook or spine, entirely blackened and sclerotized, very dissimilar in appearance to the outer lobe of the basistyle (Figs. 22–23) 5
5. Outer lobe of basistyle greatly produced, subequal in length to the very long, slender outer dististyle (Fig. 23) ..... *producta* Alex.
   Outer lobe of basistyle relatively short and stout, much shorter than the powerfully constructed hook-like outer dististyle (Fig. 22) ..... *bicornuta* Alex.

Gonomyia (Lipophleps) bicornuta Alex. (Fig. 22)

1927. *Gonomyia* (*Lipophleps*) *bicornuta* Alex.; Journ. N. Y. Ent. Soc., 35: 276–277.

Belongs to the *manca* group. General coloration brown and sulphur-yellow. Rostrum and antennae black. Thoracic pleura with a broad whitish longitudinal stripe. Knobs of halteres yellow. Wings brownish gray, without stigma. Male hypopygium (Fig. 22) with the basistyle produced into a short fleshy lobe that is shorter than the outer dististyle. Outer dististyle a powerful blackened hook, symmetrical on the two sides; inner dististyle very small, with a few setae and a single powerful fasciculate bristle. Phallosome symmetrical, the aedeagus terminating in two pale rounded blades. Two entirely dusky blades, entirely glabrous, subtend the aedeagus; in addition to these there are two shorter lobes of nearly equal width, bearing several weak setae on their apical half.

Endemic in Puerto Rico. Known only from the Luquillo National Forest. Type, May 10–13, 1927 (W. A. Hoffman). An additional ♂, El Yunque, altitude 1800 feet, February 11, 1930 (M. D. Leonard).

Gonomyia (Lipophleps) bifiligera sp. n. (Figs. 15, 21)

Belongs to the *manca* group; general coloration of mesonotum dark brown, the scutellum yellow; antennal pedicel large, blackened; thoracic pleura yellow, striped with dark brown; legs brownish black; wings grayish, stigma lacking; male hypopygium with the basistyles very long and slender; a single, entirely fleshy dististyle; elements of phallosome two in number, very long and slender, extending caudad beyond the level of the distal ends of styli.

Male.—Length about 2.5 mm.; wing 2.8—3 mm.

Described from alcoholic specimens.

Rostrum obscure yellow; palpi dark brown. Antennae brownish black, the pedicel enlarged and more intensely blackened. Head obscure yellow in front, more grayish brown on posterior vertex and occiput, the posterior orbits broadly yellow.

Mesonotum chiefly dark brown, the scutellum and posterolateral portions of scutal lobes yellow. Pleura yellow, with two conspicuous, dark brown, longitudinal stripes, the more dorsal one widest on anepisternum, narrowed behind to a sutural marking along ventral edge of pteropleurite; ventral stripe more extensive, including the sternopleurite and meral region. Halteres dusky, the knobs pale yellow. Legs with the coxae yellow, the fore coxae darkened; trochanters chiefly dusky; remainder of legs brownish black. Wings (Fig. 15) with a strong grayish tinge; stigma lacking; veins pale brown. Venation: *Sc*, ending some distance before origin of *Rs*, the distance on costa being nearly equal to *Rs* alone; branches of *Rs* strongly divergent.

Abdominal tergites light brown, the sternites and hypopygium more yellowish. Male hypopygium (Fig. 21) with the basistyles very long and slender, the single dististyle entirely fleshy, terminating in two stout fasciculate setae. Phallosome

consisting of two very elongate, slender structures that extend caudad beyond the level of the tips of the styli; one rod at apex bears abundant short setae, the second structure more slender, glabrous, very gradually narrowed to an acute point.

Habitat.—Puerto Rico.

Holotype, alcoholic ♂, Las Cruces, altitude 1300 feet, March 28, 1930 (M. D. Leonard). Paratopotypes, 3 alcoholic ♂♂.

Gonomyia (*Lipophleps*) *bifiligera* is allied to species such as *G.* (*L.*) *cubana* Alex., yet is very distinct in the structure of the male hypopygium, notably the two filiform rods of the phallosome.

Gonomyia (Lipophleps) helophila Alex. (Fig. 20)

1916. *Gonomyia* (*Leiponeura*) *helophila* Alex.; Ent. News, 27:343–346, fig. 1 (wing), 3 (male hypopygium).

1916. *Gonomyia* (*Leiponeura*) *helophila* Alex.; Proc. Acad. Nat. Sci. Philadelphia, 1916:514, pl. 29, fig. 60 (male hypopygium).

Belongs to the *cinerea* group. Antennal scape brownish black beneath, remainder of organ yellowish brown. Head yellow, with a brownish mark on vertex. Mesonotal praescutum light gray, with four more brownish stripes. Pleura dark brown, with two whitish longitudinal stripes. Legs with the fore femora brownish black; middle femora yellow, tipped with dark brown; hind femora brownish yellow, the tips slightly more darkened; tibiae white, the extreme base and slightly broader apex dark brown. Wings with costal margin china-white; remainder of wing subhyaline; stigma oval, brown, preceded and followed by more whitish spots. Venation: Sc_1 ending some distance before origin of *Rs*. Abdominal tergites brown, their caudal margins light yellow. Male hypopygium (Fig. 20) with a slender outer spinous dististyle. Ventral dististyle with a blackened finger-like lobe on margin near base. Dorsal dististyle a small oval unarmed lobe.

Male.—Length about 4.5—5.2 mm.; wing 5—5.5 mm.

Female.—Length about 4.8—5.5 mm.; wing 5.2—5.8 mm.

Ranges from Texas, south on continent to Peru; in the Antilles, Puerto Rico and Dominica.

Puerto Rico: Santurce, March 1932 (M. D. Leonard). Coamo Springs, July 17–19, 1914 (A.M.N.H.). Puerto Real, Vieques Is., at light, September 25–27, 1931 (M. D. Leonard).

The only local representative of a very extensive group of chiefly Neotropical Gonomyiæ. It is readily told by the open cell M_2 of the wings, together with the white costal border, and the china-white tibiae.

Gonomyia (Lipophleps) pleuralis (Will.).

1896. *Atarba pleuralis* Will.; Trans. Ent. Soc. London 1896: 289, pl. 10, fig. 61 (wing).

1912. *Gonomyia* (*Leiponeura*) *pleuralis* Alex.; Ent. News, 23: 419–420, figs. 3, 4 (male hypopygium).

1916. *Gonomyia* (*Leiponeura*) *pleuralis* Alex.; Proc. Acad. Nat. Sci. Philadelphia, 1916: 516, pl. 26, fig. 20 (wing).

Mesonotum light brownish yellow, margined laterally with whitish, the latter color separated from the dorsum by a narrow darker line. Pleura almost white, striped longitudinally with dark brown. Legs with the trochanters and femora light yellow, the latter with a subterminal brown ring. Wings with a grayish tinge, the costal border narrowly more yellowish; a conspicuous dark brown stigmal area; region of cord variegated by small more hyaline areas. Abdomen yellow, the segments bordered by dark brown.

Male.—Length about 3—3.5 mm.; wing 3—3.3 mm.

A wide-ranging species, Georgia and Florida; Bermudas; southward through the Antilles to British Guiana and Brazil.

Puerto Rico: Aguadilla, January 1899 (A. Busck); U.S.N.M. Coamo Springs Hotel, at light, April 4, 1930 (M. D. Leonard). Santurce, March 26, 1930 (W. A. Hoffman); April 19, 1930 (M. D. Leonard).

Again the only local representative of a very large and widespread group of tropical American Gonomyiæ. It is readily told from the other local *Lipophleps* by the dark brown stigmal area.

Gonomyia (Lipophleps) producta Alex. (Fig. 23)

1919. *Gonomyia* (*Leiponeura*) *producta* Alex.; Journ. N. Y. Ent. Soc., 27: 139–140.

Belongs to the *manca* group. General appearance much as in *bicornuta* Alex., as described. Male hypopygium (Fig. 23) distinctive, notably the long slender apical lobe of the basistyle and the very long and slender, symmetrical outer dististyle. These latter are of a length and slenderness found otherwise only in *G.* (*L.*) *prolixistylus* Alex.

Male.—Length about 2.5—3 mm.; wing 2.5—3.2 mm.

Known only from Antigua, Lesser Antilles, and Puerto Rico.

Puerto Rico: Puerto Real, Vieques Is., at light, September 25–27, 1931 (M. D. Leonard).

Gonomyia (Lipophleps) subterminalis Alex. (Fig. 24)

1927. *Gonomyia* (*Lipophleps*) *subterminalis* Alex.; Journ. N. Y. Ent. Soc., 35: 275–276.

Belongs to the *manca* group. Antennae black throughout. Mesonotum brown, the postnotum variegated with yellow. Pleura striped with pale brown and

testaceous. Wings with an unusually strong dusky tinge. Abdomen dark brown, the hypopygium obscure yellow. Male hypopygium (Fig. 24) with a single, subterminal dististyle that bears a small pale basal triangular point on outer margin near base; outer portion of dististyle with a very powerful subterminal fasciculate seta. The outer lobe of basistyle and the dististyle are generally equal in form and size.

Male.—Length about 3—3.5 mm.; wing 3.6—3.8 mm.

Known only from the mountainous sections of the Luquillo National Forest, Puerto Rico; a very close ally in the Cuban mountains. Type, a male, Luquillo, May 10–13, 1927 (W. A. Hoffman), taken along the steep rocky sides and on the vegetation along a mountain stream. Other material, El Yunque, 1800 feet, February 11, 1930; 2000–3500 feet, March 29, 1930 (M. D. Leonard). Las Cruces, altitude 1300 feet, March 28, 1930 (M. D. Leonard).

The peculiar structure of the male hypopygium is very distinctive.

Although only representatives of the subgenus *Lipophleps* have yet been taken in Puerto Rico, three additional subgeneric groups, *Progonomyia* Alex., *Gonomyia* Meig. and *Ptilostena* Berg., have been taken in Cuba and are thus regional.

(The genus *Teucholabis* O. S. is one of the largest and most characteristic groups of Eriopterine Tipulidae, being especially rich in species in tropical America. Several species have been found in Cuba and Jamaica but none, as yet, has been taken in Puerto Rico. The venation of the Cuban *Teucholabis nigrosignata* Alex. is shown, Fig. 16.)

Subtribe Trentepohliaria

Trentepohlia (Paramongoma) niveitarsis (Alex.) (Fig. 17)

1913. *Mongoma niveitarsis* Alex.; Proc. U. S. Nat. Mus., 44: 501, pl. 65, fig. 13 (wing).

1928. *Trentepohlia* (*Paramongoma*) near *niveitarsis* Alex.; Dept. Sci. and Agr. Jamaica, Ent. Bull. 4: 25.

General coloration dark brown, including the head and appendages. Halteres elongate, brown. Legs dark brown, the terminal three tarsal segments white; in cases, the amount of white is more extensive, including all the tarsal segments, as well as the extreme tips of the tibiae. Wings (Fig. 17) subhyaline, the costal margin and stigma somewhat darker brown; veins dark brown.

Male.—Length about 6 mm.; wing about 5 mm.

Female.—Length about 6.5—7 mm.; wing 5.5—6.3 mm.

Known only from the mountains of Puerto Rico and Jamaica. El Yunque, Luquillo National Forest, altitude 2850 feet, February 25–27, 1900 (C. W. Richmond); types. One ♀, Luquillo Forest,

May 10–13, 1927 (W. A. Hoffman). El Yunque, altitude 1800 feet, February 11, 1930 (M. D. Leonard). Also what appears surely to represent this same species, Cinchona, Blue Mts., Jamaica, July 25, 1926 (G. C. Crampton); 1 broken ♂.

This very characteristic fly is the most northerly representative of the great genus *Trentepohlia* in the New World. It bears a superficial resemblance to *Helius* (*Helius*) *albitarsis* (O. S.), which is in reality a very different fly.

Subtribe Eriopteraria

The only representatives of the extensive genus *Erioptera* Meig. in Puerto Rico are members of the subgenus *Mesocyphona* O. S., which reaches its greatest development of species in the American Tropics and Subtropics. Two species of *Mesocyphona* have been taken in Puerto Rico, one of which is widespread throughout eastern North America, the other being endemic. In the high mountains of Jamaica occurs a second subgenus of *Erioptera*, *Empeda* O. S., with a single very distinct species.

A KEY TO THE PUERTO RICAN SPECIES

1. Wings dark brown, with abundant white spots and dots in all the cells---- *caloptera* Say
   Wings subhyaline, unspotted---- *portoricensis* sp. n.

Erioptera (Mesocyphona) caloptera Say

1823. *Erioptera caliptera* Say; Journ. Acad. Nat. Sci. Philadelphia, 3:17.

1869. *Erioptera caloptera* O. S.: Mon. Dipt. N. Amer., 4:161–162, pl. 4, fig. 15 (male hypopygium).

1919. *Erioptera caloptera* Alex.; Crane-flies of New York, part 1: 908, pl. 35, fig. 77 (wing).

General coloration brownish yellow, the praescutum with two clearly defined dark brown stripes. Thoracic pleura striped longitudinally with dark brown and pale. Femora yellow, each with two brown annuli, one medial, the other subterminal. Wings brownish, more saturated near costal border, the entire disk variegated by white spots and dots, including somewhat larger areas beyond arculus, at origin of *Rs*, at Sc_2, along cord, and at tips of veins R_{1+2} and R_3.

Male.—Length about 3.5 mm.; wing about 3.5 mm.

Female.—Length about 4 mm.; wing about 3.5 mm.

The species *caloptera* (originally spelled *caliptera* by Say) is widely-distributed throughout the eastern United States. The Puerto Rican material here referred to *caloptera* has the white wing spots

somewhat more reduced in area than do specimens of the typical form from the northern United States.

Puerto Rico: El Yunque, Luquillo National Forest, altitude 1800 feet, February 11, 1930; March 29, 1930 (M. D. Leonard).

Erioptera (Mesocyphona) portoricensis sp. n. (Fig. 18)

Mesonotal praescutum dark brown, with three reddish brown stripes; pleura dark brown, striped longitudinally with whitish; wings immaculate, grayish, the costal border more yellowish; male hypopygium with the phallosome large, produced laterally into a conspicuous straight spine on either side.

Male.—Length about 2.8—3 mm.; wing 2.8—3 mm.

Described from alcoholic specimens.

Rostrum whitish; palpi black. Antennae black; pedicel enlarged, globular; flagellum short, the basal segments crowded. Head whitish, with a conspicuous dark brown area on vertex.

Pronotum dark brown, paler laterally. Mesonotal praescutum dark brown the three usual stripes pale reddish brown; scutum dark brown, the centers of the lobes reddish brown; scutellum whitish; postnotum dark brown. Pleura dark brown with a conspicuous white longitudinal stripe in addition to the broad similarly-colored dorso-pleural region; ventral longitudinal pale line extending from behind the fore coxae to the abdomen, passing beneath the halteres, broadest on the pteropleurite. Halteres pale yellow. Legs with the fore and middle coxae dark brown, the posterior coxae somewhat paler; trochanters pale, especially the posterior ones; fore femora with a single subterminal brown ring; remaining femora with two such darkened rings (the posterior legs are all detached in vials, but the condition seems to be as described). Wings (Fig. 18) grayish, immaculate, more darkened basally, the costal region conspicuously light yellow; veins brownish yellow, clearer yellow in the flavous areas. Venation: Cell M_1 open by atrophy of the basal section of M_3.

Abdomen dark brown, the ninth segment obscure yellow, the styli again conspicuously blackened. Male hypopygium with the dististyles slender; outer style a nearly straight simple rod, the inner style bifid nearly to base, its outer arm longer, the inner arm shorter and very slender. Gonapophyses appearing as simple smooth arms that curve gently toward one another, the obtuse tips dusky. Phallosome large and conspicuous, the body large with a conspicuous lateral spine on either side, these directed laterad and slightly caudad.

Habitat.—Puerto Rico.

Holotype, alcoholic ♂, El Yunque, Luquillo National Forest, altitude 1800 feet, February 11, 1930 (M. D. Leonard).

Paratopotypes, several ♂♂, 1800–3500 feet, February 11—March 29, 1930 (M. D. Leonard); paratypes, a few broken specimens, Las Cruces, altitude 1300 feet, March 28, 1930 (M. D. Leonard).

Erioptera (*Mesocyphona*) *portoricensis* is very different from the other described species of the subgenus having unspotted wings.

(The genus *Rhabdomastix* Skuse, subgenus *Sacandaga* Alex., is found in Jamaica and Hispaniola, but to date not in Puerto Rico.

The sole Antillean species is *R.* (*S.*) *parva* (Alex.), a small brown fly with grayish wings. The characters given for the genus in the key will suffice for the separation of this insect. The only regional genus with which it might be confused is *Gonomyia* s.s., which is most readily told by the short to very short *Sc;* in *parva Sc* is long, Sc_1 extending to beyond midlength of *Rs.*)

Subtribe Toxorhinaria

The only genus in this very peculiar subtribe is *Toxorhina* Lw., with a small number of chiefly tropical species in both hemispheres.

Toxorhina (Toxorhina) fragilis Lw. (Fig. 19)

1851. *Toxorhina fragilis* Lw.; Linn. Ent., 5: 401–402, pl. 2, fig. 16 (antenna), 17 (entire insect), 18 (venation), 22 (head).

Thorax dark brown, somewhat pruinose; praescutum with a dark gray median stripe but with lateral stripes not clearly evident: extreme lateral margin of praescutum almost whitish. Antennae brownish black. Femora bright brown, darker toward tip; tibiae somewhat brighter, with darker tips. Wings with a faint grayish tinge; stigma lacking; veins of costal region brownish yellow, the others darker brown. Abdomen brown, the incisures darker.

Loew's type, a female, was taken by Moritz in Puerto Rico. Unfortunately no material agreeing entirely with the above diagnosis has ever been taken and it seems probable that the darkening of the tips of the femora and tibiae of *fragilis* is less evident than is implied by Loew's description. I have shown the venation of *Toxorhina* (*Toxorhina*) *centralis* Alex., (Fig. 19), the commonest species in the northern part of South America. The fly that seems closest to *fragilis*, specimens of which I have seen from Cuba and Hispaniola, but not from Puerto Rico, is relatively small.

Male.—Length, excluding rostrum, about 6.5 mm.; wing 6 mm.; rostrum about 5 mm.

V. A List of the Tipulidae Known from the Greater Antilles

TIPULINAE

Nephrotoma, sp. (*ferruginea* Fabr., var.); mss. record. Cuba, Hispaniola.

Tipula (*Tipula*) *jamaicensis* Alex.; Dept. Sci. & Agr. Jamaica, Ent. Bull. 4: 27–28; 1928. Jamaica.

Tipula (*Tipula*) *ludoviciana* Alex.; mss. record. Cuba.

Dolichopeza (*Megistomastix*) *cubensis* (Alex.); Journ. N. Y. Ent. Soc., 36: 47–48; 1928 (*Megistomastix*). Cuba.

Dolichopeza (*Megistomastix*) *portoricensis* (Alex.); Psyche, 19: 65–66; 1912 (*Megistomastix*). Puerto Rico.

Brachypremna unicolor O. S.; Berlin. Ent. Zeitschr., 31:239; 1887. Cuba, Hispaniola, Puerto Rico.

Megistocera longipennis (Macq.); Dipt. exot., 1, pt. 1:57; 1838 (*Tipula*). Cuba, Hispaniola, Puerto Rico.

LIMONIINAE

Limoniini

Limonia (*Limonia*) *basistylata* Alex.; Dept. Sci. & Agr. Jamaica, Ent. Bull. 4:19–20; 1928. Jamaica.

Limonia (*Limonia*) *caribæa* sp. n.; this paper, conclusion. Cuba.

Limonia (*Limonia*) *hoffmani* Alex.; Journ. N. Y. Ent. Soc., 35:265–266; 1927. Puerto Rico.

Limonia (*Limonia*) *jamaicensis* Alex.; *Ibid.*, 34:223–224; 1926. Jamaica.

Limonia (*Discobola*) *gowdeyi* sp. n.; this paper, conclusion. Cuba, Jamaica.

Limonia (*Neolimnobia*) *diva* (Schin.); Novara Reise, Diptera, p. 46; 1868 (*Limnobia*). Cuba, Jamaica, Puerto Rico.

Limonia (*Dicranomyia*) *brevivena torrida* subsp. n.; this paper. Puerto Rico.

Limonia (*Dicranomyia*) *distans* (O. S.); Proc. Acad. Nat. Sci. Philadelphia, 1859:211; Del., 1859. Puerto Rico.

Limonia (*Dicranomyia*) *divisa* Alex.; Philippine Journ. Sci., 40:247; 1929. Hispaniola, Puerto Rico.

Limonia (*Dicranomyia*) *reticulata* (Alex.); Canad. Ent., 44:334–335; 1912 (*Furcomyia*). Cuba.

Limonia (*Dicranomyia*) *trinitatis* Alex.; Journ. N. Y. Ent. Soc., 39:110–111; 1931. Cuba.

Limonia (*Rhipidia*) *domestica* (O. S.); Proc. Acad. Nat. Sci. Philadelphia, 1859:208; 1859 (*Rhipidia*). Cuba, Hispaniola, Jamaica, Puerto Rico.

Limonia (*Rhipidia*) *schwarzi* (Alex.); Bull. Brooklyn Ent. Soc., 8:13–14; 1912 (*Rhipidia*). Cuba, Hispaniola, Jamaica.

Limonia (*Rhipidia*) *subcostalis* (Alex.); Proc. U. S. Nat. Mus., 60, art. 25:3–4; 1922 (*Rhipidia*). Jamaica.

Limonia (*Geranomyia*) *antillarum* Alex.; Journ. N. Y. Ent. Soc., 37:395–396; 1929. Cuba, Hispaniola, Jamaica, Puerto Rico.

Limonia (*Geranomyia*) *cinereinota* (Alex); Ent. News, 24:407–408; 1913 (*Geranomyia*). Hispaniola, Puerto Rico.

Limonia (*Geranomyia*) *cubana* Alex.; Journ. N.Y. Ent. Soc., 37:396–397; 1929. Cuba.

Limonia (*Geranomyia*) *domingensis* (Alex.); Proc. Acad. Nat. Sci. Philadelphia, 1916:490–491; 1916 (*Geranomyia*). See *L.* (*G.*) *cinereinota* (Alex.).

Limonia (*Geranomyia*) *intermedia* (Walk.); List Diptera Brit. Mus., 1:47; 1848. (*Limnobia*). Jamaica.

Limonia (*Geranomyia*) *myersiana* Alex.; Journ. N. Y. Ent. Soc., 37: 397–398; 1929. Cuba.

Limonia (*Geranomyia*) *rostrata* (Say), Antillean references erroneous, see *L.* (*G.*) *antillarum* Alex.

Limonia (*Geranomyia*) *rufescens* (Lw.); Linnaea Ent., 5:396; 1851 (*Aporosa*). Puerto Rico.

Limonia (*Geranomyia*) *subrecisa* sp. n.; this paper. Puerto Rico.

Limonia (*Geranomyia*) *subvirescens* Alex.; Journ. N. Y. Ent. Soc., 38:112; 1930. Cuba.

Limonia (*Geranomyia*) *tibialis* (Lw.); Linnaea Ent., 5:397; 1851 (*Aporosa*). Cuba, Jamaica, Puerto Rico.

Limonia (*Geranomyia*) *virescens* (Lw.); Ibid., 5:398; 1851 (*Aporosa*). Puerto Rico.

Helius (*Helius*) *albitarsis* (O. S.); Berlin. Ent. Zeitschr., 31:184; 1887 (*Rhamphidia*). Cuba, Puerto Rico.

Helius (*Helius*) *creper* Alex.; Journ. N. Y. Ent. Soc., 34:225; 1926. Jamaica.

Orimarga (*Orimarga*) *cubensis* sp. n.; this paper, conclusion. Cuba.

Orimarga (*Diotrepha*) *flavicosta* (Alex.); Dept. Sci. & Agr. Jamaica, Ent. Bull. 4:23; 1928 (*Diotrepha*). Jamaica.

Orimarga (*Diotrepha*) *mirabilis* (O. S.); Cat. Dipt. N. Amer., Ed. 2; 27, 28; 1878 (*Diotrepha*).

Hexatomini

Epiphragma buscki Alex., Proc. U. S. Nat. Mus., 44:540–541; 1913. Hispaniola.

Epiphragma cubensis Alex.; Journ. N. Y. Ent. Soc., 37:403–404; 1929. Cuba.

Polymera (*Polymera*) *geniculata* Alex.; Insec. Inscit. Menst., 3:106–107; 1915. Puerto Rico.

Polymera (*Polymera*) *obscura* Macq.; Dipt. exot., 1, pt. 1:65; 1838. Cuba.

Shannonomyia brevicula Alex.; Journ. N. Y. Ent. Soc., 39:113–114; 1931. Cuba.

Shannonomyia leonardi sp. n.; this paper. Puerto Rico.

Shannonomyia mesophragma Alex.; Journ. N. Y. Ent. Soc., 36:52–53; 1928. Cuba.

Shannonomyia myersiana Alex.; *Ibid.*, 39:112–1131; 1931. Jamaica.

Shannonomyia nacrea (Alex.); Proc. U. S. Nat. Mus., 44:544–545; 1913 (*Limnophila*). Jamaica.

Shannonomyia triangularis (Alex.); Journ. N. Y. Ent. Soc., 35:270; 1927 (*Pilaria*). Puerto Rico.

Atarba (*Atarba*) *angustipennis* Alex.; *Ibid.*, 36:57; 1928. Cuba.

Hexatoma (*Eriocera*) *acuñai* (Alex.); *Ibid.*, 56–57; 1928 (*Eriocera*). Cuba.

Hexatoma (*Eriocera*) *ætherea* (Alex.); Ent. News, 27:346; 1916 (*Eriocera*). Hispaniola.

Hexatoma (*Eriocera*) *bruneri* (Alex.); Journ. N. Y. Ent. Soc., 36: 55–56; 1928 (*Eriocera*). Cuba.

Hexatoma (*Eriocera*) *cramptoni* (Alex.); Dept. Sci. & Agr. Jamaica, Ent. Bull. 4:23–24; 1928 (*Eriocera*). Jamaica.

Hexatoma (*Eriocera*) *cubensis* (Alex.); Journ. N. Y. Ent. Soc., 34: 229–230; 1926 (*Eriocera*). Cuba.

Hexatoma (*Eriocera*) *domingensis* (Alex.); Ent. News, 27:346–347; 1916 (*Eriocera*). Hispaniola.

Hexatoma (*Eriocera*) *ocellifera* (Alex.); Insec. Inscit. Menst., 3: 104–106; 1915 (*Eriocera*). Puerto Rico.

Hexatoma (*Eriocera*) *trifasciata* (Röder); Stett. Ent. Zeitg., 56: 338; 1885 (*Eriocera*). Puerto Rico.

Elephantomyia westwoodi antillarum subsp. n.; this paper, conclusion. Cuba, Hispaniola.

Eriopterini

Gonomyia (*Progonomyia*) *slossonæ* Alex.; Proc. Acad. Nat. Sci. Philadelphia, 1914:588–589; 1914; Ann. So. African Mus., 17:152; 1917. Jamaica.

Gonomyia (*Gonomyia*) *brevicula* Alex., Journ. N. Y. Ent. Soc., 34: 225–226; 1926. Cuba.

Gonomyia (*Gonomyia*) *brevissima* Alex.; *Ibid.*, 34:227; 1926. Cuba.

Gonomyia (*Ptilostena*) *angustissima* Alex.; *Ibid.*, 36:57–58; 1928. Cuba.

Gonomyia (*Lipophleps*) *bicornuta* Alex.; *Ibid.*, 35:276–277; 1927. Puerto Rico.

Gonomyia (*Lipophleps*) *bifiligera* sp. n.; this paper. Puerto Rico.

Gonomyia (*Lipophleps*) *cubana* Alex.; Journ. N. Y. Ent. Soc., 39: 120–121; 1931. Cuba.

Gonomyia (*Lipophleps*) *helophila* Alex.; Ent. News, 27:343–345; 1916. Puerto Rico.

Gonomyia (*Lipophleps*) *pleuralis* (Will.); Trans. Ent. Soc. London, 1896:289; 1896 (*Atarba*). Cuba, Jamaica, Puerto Rico.

Gonomyia (*Lipophleps*) *producta* Alex.; Journ. N. Y. Ent. Soc.. 27: 139–140; 1919. Puerto Rico.

Gonomyia (*Lipophleps*) *puer* Alex.; Proc. U. S. Nat. Mus., 44:506; 1913. Hispaniola, Jamaica.

Gonomyia (*Lipophleps*) *sandersi* Alex.; Journ. N. Y. Ent. Soc., 39: 121–122; 1931. Cuba.

Gonomyia (*Lipophleps*) *subterminalis* Alex.; *Ibid.*, 35:275–276; 1927. Puerto Rico.

Teucholabis (*Teucholabis*) *bruneri* Alex.; *Ibid.*, 34:227–228; 1928. Cuba.

Teucholabis (*Teucholabis*) *chalybeiventris* (Lw.); Wien. Entomol. Monatschr., 5:33; 1861 (*Rhamphidia*). Cuba.

Teucholabis (*Teucholabis*) *gowdeyi* Alex.; Dept. Sci. & Agr. Jamaica, Ent. Bull. 4:25–27; 1928. Jamaica.

Teucholabis (*Teucholabis*) *gowdeyi nigroterminalis* subsp. n.; this paper, conclusion. Cuba.

Teucholabis (*Teucholabis*) *myersi* Alex.; Journ. N. Y. Ent. Soc., 34: 228–229; 1928. Cuba.

Teucholabis (*Teucholabis*) *nebulipennis* Alex.; Dept. Sci. & Agr. Jamaica, Ent. Bull. 4:27; 1928. Jamaica.

Teucholabis (*Teucholabis*) *nigrosignata* Alex.; Journ. N. Y. Ent. Soc., 39:118–119; 1931. Cuba.

Trentepohlia (*Paramongoma*) *niveitarsis* (Alex.); Proc. U. S. Nat. Mus., 44:501; 1913 (*Mongoma*). Jamaica, Puerto Rico.

Rhabdomastix (*Sacandaga*) *parva* (Alex.); *Ibid.*, 44:508–509; 1913 (*Sacandaga*). Hispaniola, Jamaica.

Erioptera (*Mesocyphona*) *caloptera* Say; Journ. Acad. Nat. Sci. Philadelphia, 3:17; 1823. Cuba, Puerto Rico.

Erioptera (*Mesocyphona*) *costalis* Alex.; Proc. U. S. Nat Mus., 44: 517–518; 1913. Cuba.

Erioptera (*Mesocyphona*) *portoricensis* sp. n.; this paper. Puerto Rico.

Erioptera (*Empeda*) *nymphica* Alex.; Dept. Sci. & Agr. Jamaica, Ent. Bull. 4:24–25; 1928. Jamaica.

Toxorhina (*Toxorhina*) *fragilis* Lw.; Linnaea Ent., 5:401; 1851. Puerto Rico.

A few new species and subspecies of extra-Puerto Rican Tipulidae are described herewith in order to complete the record for the Greater Antilles.

Limonia (Limonia) caribaea sp. n. (Fig. 25)

General coloration yellow; mesonotal praescutum with three brownish black stripes; thoracic pleura with a broad dorsal black stripe, together with a reduced ventral area on the sternopleurite; legs chiefly black; wings faintly tinged with brownish, with a restricted darker brown pattern; *Rs* square and short-spurred at origin; *m-cu* longer than distal section of Cu_1; male hypopygium with the ventral dististyle bearing a single pale rostral spine; gonapophyses unusually powerful, blackened, the mesal apical lobe bidentate.

Male.—Length about 5.5 mm.; wing 6.2 mm.

Rostrum and palpi black. Antennae black throughout; flagellar segments elongate-oval, with long, unilaterally arranged verticils. Head with the frons and anterior vertex silvery gray, the posterior vertex darker.

Pronotum obscure yellow, with a narrow, dark, longitudinal line on either side. Mesonotal praescutum yellow, with three brownish black stripes that are all more or less confluent near their anterior ends; median stripe not reaching the anterior margin of sclerite and more or less split by a capillary pale vitta; posterior sclerites of mesonotum chiefly pale brown, the posterior border of the postnotal mediotergite darker, this being the end of a conspicuous black pleural stripe. Pleura yellow, with the stripe just described, together with a similar intense blackened area on the ventral sternopleurite. Halteres dark brown. Legs with the coxae and trochanters light yellow; femora dark brown, their bases restrictedly paler, the tips narrowly still darker brown; tibiae and tarsi black. Wings with a faint brownish tinge, the prearcular and costal regions more yellowish; a restricted dark brown pattern, as follows: Origin of *Rs*; fork of *Sc*; along cord and outer end of cell *1st* M_2; stigma; pale brown streaks in centers of cells R_1, R_2, R_3 and R_5; veins brown. Venation: Sc_1 long, ending just beyond midlength of *Rs*, Sc_2 at its tip; *Rs* nearly square and weakly spurred at origin; free tip of Sc_2 and R_2 in transverse aligment; *m-cu* at fork of *M*, about one-half longer than the distal section of Cu_1.

Abdominal segments dimidiate, pale yellow basally, the apical half and narrower lateral margins dark brown, the amount of dark increasing on the outer segments. Male hypopygium (Fig. 25) of somewhat remarkable structure. Ninth tergite transverse, the caudal margin with two rounded lobes. Ventro-mesal lobe of basistyle very large. Dorsal dististyle a slender, nearly straight rod, before the apex a little widened and gently curved, the tip acute. Ventral dististyle smaller than the basistyle, white, deeply divided by a dorsal notch in which the dorsal dististyle rests; rostral prolongation a pale, compressed blade, at its base with a setiferous area that includes a single pale rostral spine. Gonapophyses very large and powerfully constructed, the mesal apical lobe stout, bidentate. Aedeagus broad, each outer apical angle bearing a small lobe.

Habitat.—Cuba.

Holotype, ♂, San Blás, Santa Clara, Trinidad Mts., altitude about 700 feet, May 5, 1932 (Bruner and Otero).

This very distinct *Limonia* requires no comparison with any described members of the subgenus. The peculiar structure of the hypopygium is quite different from any of the described Neotropical species.

Limonia (Discobola) gowdeyi sp. n. (Fig. 26)

General coloration yellow and black; antennal flagellum black; apices of knobs of halteres blackened; tibiae narrowly blackened at bases; wings the usual ocellate pattern arranged in five more or less complete fasciae.

Male.—Length about 10 mm.; wing 13 mm.

Female.—Length about 9 mm.; wing 9.5 mm.

Rostrum and palpi black. Antennae black throughout; flagellar segments (female) narrowly subcordate, with short apical pedicels; terminal segment more slender, about one-third longer than the penultimate. Head behind light brown, more grayish in front.

Pronotum yellowish. Mesonotal praescutum obscure yellow, with five brown lines on posterior half, these including the posterior ends of three more or less confluent discal stripes, together with the darker lateral margins of the sclerite; scutum yellow, each lobe with a ring-like brown area; scutellum black, obscure yellow medially at base; postnotal mediotergite chiefly blackened. Pleura greenish yellow, handsomely variegated with black, including the middle coxae, sternopleurite and ventral half of anepisternum, from which last-named a black band extends caudad across the pteropleurite and pleurotergite to the postnotal mediotergite; a narrower incomplete stripe extends caudad and dorsad across the meral region, nearly if not quite attaining the haltere; a linear black dash on margin of dorso-pleural membrane. Halteres chiefly black, the base of stem and base of knob pale. Legs with the coxae yellow, the mid-coxae black, as described; trochanters yellow; femora yellow, slightly darkened outwardly, the broad apex abruptly clear light yellow, enclosing a narrow subterminal black ring that is a little wider than the terminal yellow annulus and subequal to the basal pale annulus; tibiae obscure yellow, the proximal end just beyond base and the apex narrowly and subequally blackened; terminal tarsal segments passing into dark brown. Wings cream-yellow, more saturated at base and in costal region; extreme base of wing darkened; the usual ocellate pattern is arranged as five crossbands, complete or nearly so, the first at base and before the supernumerary crossvein, the latter lying in the first pale interspace; second dark fascia broad, with the origin of *Rs* as a center; third fascia along cord; fourth composed of two contiguous ocelli, with R_2 and outer end of cell *1st* M_2 as centers; outermost fascia at wing-apex, broken; the three outer interspaces are occupied by dark posterior marginal spots at ends of veins *1st A*, Cu_1 and M_4, respectively; veins yellow, brown in the clouded areas. Venation: Cell *1st* M_2 long-rectangular, the second and third sections of M_3+_2 subequal; *m-cu* just beyond fork of *M*.

Abdominal tergites dimidiate, the bases blackened, the apices yellow; on proximal segments, the black areas are more restricted to the lateral portions, on the third to seventh segments the black bands are continuous and gradually increasing in area on the outer sclerites; genital segments obscure yellow.

The allotype male is much larger than the type female but seems unquestionably to belong here. The dark band-like fasciae of the wings are more broken, with more extensive pale centers, yet retain the five-banded appearance of the type. Male hypopygium (Fig. 26) agreeing in its general features with *L.* (*D.*) *argus* (Say) but differing in several regards. The ventral dististyle is much longer, with the outer lobe produced; rostral spines at the base of the prolongation but not arising in hyaline membrane, as in *argus*; apex of the prolon-

gation extended into a small sclerotized point. Lobe on mesal face of basistyle very extensive.

Habitat.—Cuba, Jamaica.

Holotype, ♀, Cinchona, Blue Mts., Jamaica, June 1889 (W. Fawcett); Brit. Mus. Access. No. 89–80. Allotype, ♂, San Blás, Santa Clara, Trinidad Mts., Cuba, altitude 700 feet, December 4, 1931 (G. C. Rowe). Paratopotype, one specimen of doubtful sex, from the type-locality, August 2, 1923 (C. C. Gowdey).

The type and paratype are in the British Museum of Natural History, the allotype in the writer's collection.

Limonia (*Discobola*) *gowdeyi* is named in honor of the late Mr. C. C. Gowdey, former Entomologist for Jamaica. The species is quite distinct from all other described members of *Discobola,* being closest to *argus,* yet differing in numerous features of coloration, wing-pattern and structure of the male hypopygium. The discovery of this subgenus in the Antilles far to the south of its known range was a highly significant one.

Orimarga (Orimarga) cubensis sp. n.

General coloration black; lateral margin of praescutum and a slightly wider stripe on ventral pleura silvery; legs black; wings long-petiolate basally, nearly hyaline; R_1 meeting R_2 at an obtuse angle, with a short spur of R_{1+2} at the point of angulation; *m-cu* lying far distad, shortly before the level of the outer end of *Rs*; vein *2nd A* short.

Male.—Length about 8 mm.; wing 5 mm.

Rostrum and palpi black. Antennae broken. Head black, with a light gray pruinosity.

Pronotum and mesonotum black, the praescutum narrowly lined laterally with silvery. Pleura brown, with a ventral silvery stripe that is a little wider than the praescutal vitta. Halteres broken. Legs with the coxae and trochanters horn-colored; remainder of legs black, the extreme femoral bases paler. Wings with a long basal petiole, nearly hyaline; veins dark brown. Costal fringe (male) relatively long and dense; macrotrichia of veins beyond cord long and abundant. Venation: Sc_1 ending opposite origin of *Rs*; free tip of Sc_2 preserved; R_1 meeting R_2 at an obtuse angle, R_{1+2} being represented at this point of angulation by a tiny spur; vein M_3 a little less than three times M_{3+4}; *m-cu* lying far distad, about opposite the outer end of *Rs* and about one-third that section beyond it; vein *2nd A* unusually short.

Abdominal tergites brownish black, narrowly bordered laterally by yellowish; tip of abdomen broken.

Habitat.—Cuba.

Holotype, ♂, Sierra Rangel, Pinar del Río, August 28, 1929 (Acuña and Bruner).

The long-petiolate wings readily separate this fly from all allies,

except *O.* (*O.*) *niveitarsis* Alex. (Panama), which is readily told by the white tarsi and position of *m-cu* opposite the origin of *Rs*. The general features of venation are somewhat as in *O.* (*O.*) *wetmorei* Alex. (southern Florida) but the details are quite distinct, especially the narrow cell *2nd A* and the distal position of *m-cu*.

Elephantomyia westwoodi antillarum subsp. n. (Fig. 13)

Male.—Length, excluding rostrum, about 8.5—9.5 mm.; wing 7—8.5 mm.; rostrum about 8—8.5 mm.

Similar to typical *westwoodi* O. S., differing as follows: Antennae more uniformly infuscated. Mesonotum not or scarcely darkened medially; ventral sternopleurite restrictedly blackened. Wing-apex distinctly infumed. Abdomen almost entirely yellow, the lateral portion of tergites darkened; subterminal segment infuscated but less so than in *westwoodi*; sternites three and four with a median brown spot before caudal margin. Male hypopygium with the outer dististyle conspicuously bidentate at apex, the outer spine straighter and more slender than the curved axial or inner spine.

Habitat.—Cuba, Hispaniola.

Holotype, ♂, Buenos Aires, Trinidad Mts., Cuba, altitude 2350–2800 feet, May 3–4, 1931 (Bruner, Acuña and Otero). Paratopotypes, 2 ♂ ♂. I have also seen this from Hispaniola (Haití), taken by Dr. John G. Myers.

The relationship of the present fly to *westwoodi* seems best expressed by a trinomial.

Teucholabis (Teucholabis) gowdeyi nigroterminalis subsp. n.

Male.—Length 10—11 mm.; wing 8–85 mm.

Close to typical *gowdeyi* Alex., (Jamaica), differing most evidently in the broad black apices of all the femora. In the typical form, the corresponding markings are much narrower, dark brown, and are subterminal in position.

Habitat.—Cuba.

Holotype, ♂, Sierra Rangel, Pinar del Rio, January 27–30, 1931 (Acuña and Otero). Paratypes, 1 ♂, Buenos Aires, Trinidad Mts., altitude 2350–2800 feet, May 3, 1932 (Bruner and Otero); 1 badly damaged ♂, San Blás, Trinidad Mts. (G. C. Rowe).

Explanation of Plates

plate xliii

Fig. 1. *Megistocera longipennis* (Macq.); venation.
Fig. 2. *Brachypremna unicolor* O. S.; venation.
Fig. 3. *Dolichopeza* (*Megistomastix*) *portoricensis* (Alex.); venation.
Fig. 4. *Limonia* (*Limonia*) *hoffmani* Alex.; venation.
Fig. 5. *Helius* (*Helius*) *albitarsis* (O. S.); venation.

PLATE XLIV

Fig. 6. *Limonia* (*Limonia*) *hoffmani* Alex.; male hypopygium.
Fig. 7. *Limonia* (*Dicranomyia*) *distans* (O.S.); male hypopygium.
Fig. 8. *Limonia* (*Dicranomyia*) *divisa* Alex.; male hypopygium.

Symbols: a = ædeagus; b = basistyle; d = dististyle; dd = dorsal dististyle; g = gonapophysis; t = tergite; vd = ventral dististyle.

PLATE XLV

Fig. 9. *Orimarga* (*Diotrepha*) *mirabilis* (O. S.); venation.
Fig. 10. *Polymera* (*Polymera*) *geniculata* Alex.; venation.
Fig. 11. *Shannonomyia leonardi* sp. n.; venation.
Fig. 12. *Hexatoma* (*Eriocera*) *cubensis* (Alex.); venation.
Fig. 13. *Elephantomyia westwoodi antillarum* subsp. n.; venation.

PLATE XLVI

Fig. 14. *Epiphragma cubensis* Alex.; venation.

Symbols: A = Anal veins; C = Costa; Cu = Cubitus; M = Media; R = Radius; Rs = Radial sector.

PLATE XLVII

Fig. 15. *Gonomyia* (*Lipophleps*) *bifiligera* sp. n.; venation.
Fig. 16 *Teucholabis* (*Teucholabis*) *nigrosignata* Alex.; venation.
Fig. 17. *Trentepohlia* (*Paramongoma*) *niveitarsis* (Alex.); venation.
Fig. 18. *Erioptera* (*Mesocyphona*) *portoricensis* sp. n.; venation.
Fig. 19. *Toxorhina* (*Toxorhina*) *centralis* Alex.; venation.

PLATE XLVIII

Fig. 20. *Gonomyia* (*Lipophleps*) *helophila* Alex.; male hypopygium.
Fig. 21. *Gonomyia* (*Lipophleps*) *bifiligera* sp. n.; male hypopygium.
Fig. 22. *Gonomyia* (*Lipophleps*) *bicornuta* Alex.; male hypopygium.
Fig. 23. *Gonomyia* (*Lipophleps*) *producta* Alex.; male hypopygium.
Fig. 24. *Gonomyia* (*Lipophleps*) *subterminalis* Alex.; male hypopygium.

Symbols: b = basistyle; d = dististyle; p = phallosome.

Fig. 25. *Limonia* (*Limonia*) *caribæa* sp. n.; male hypopygium.
Fig. 26. *Limonia* (*Discobola*) *gowdeyi* sp. n.; male hypopygium.

Symbols: a = ædeagus; b = basistyle; dd = dorsal dististyle; g = gonapophysis; t = tergite; vd = ventral dististyle.

PLATE XLIII


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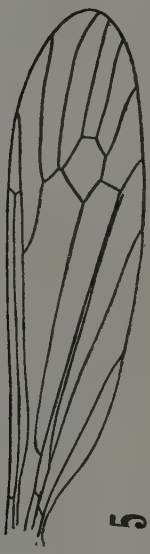
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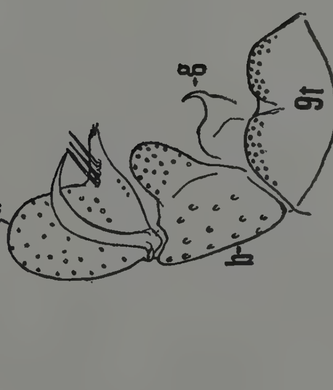
PLATE XLIV

8



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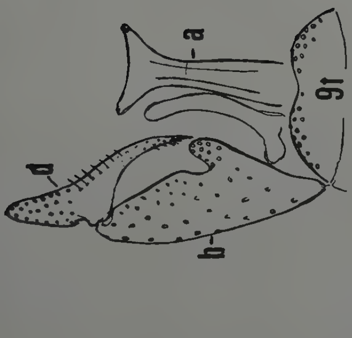

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PLATE XLV

9

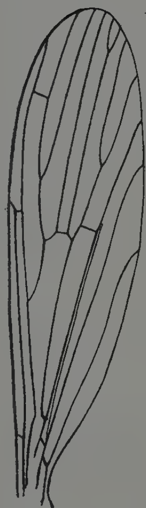

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PLATE XLVI

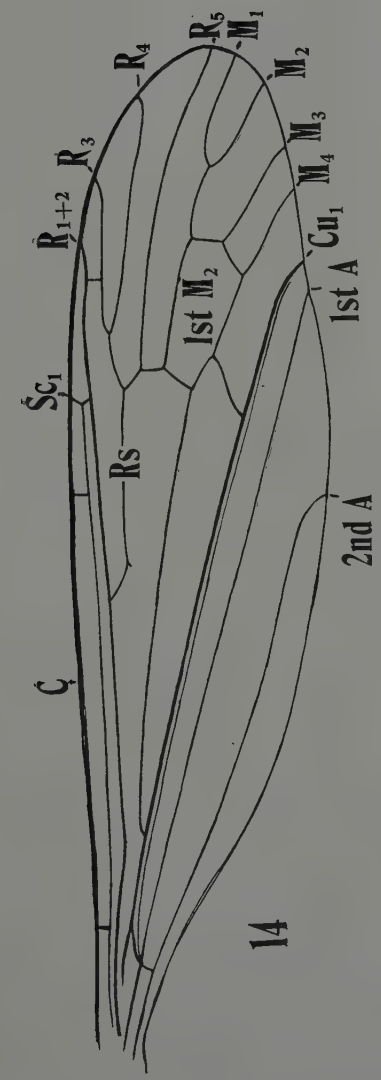

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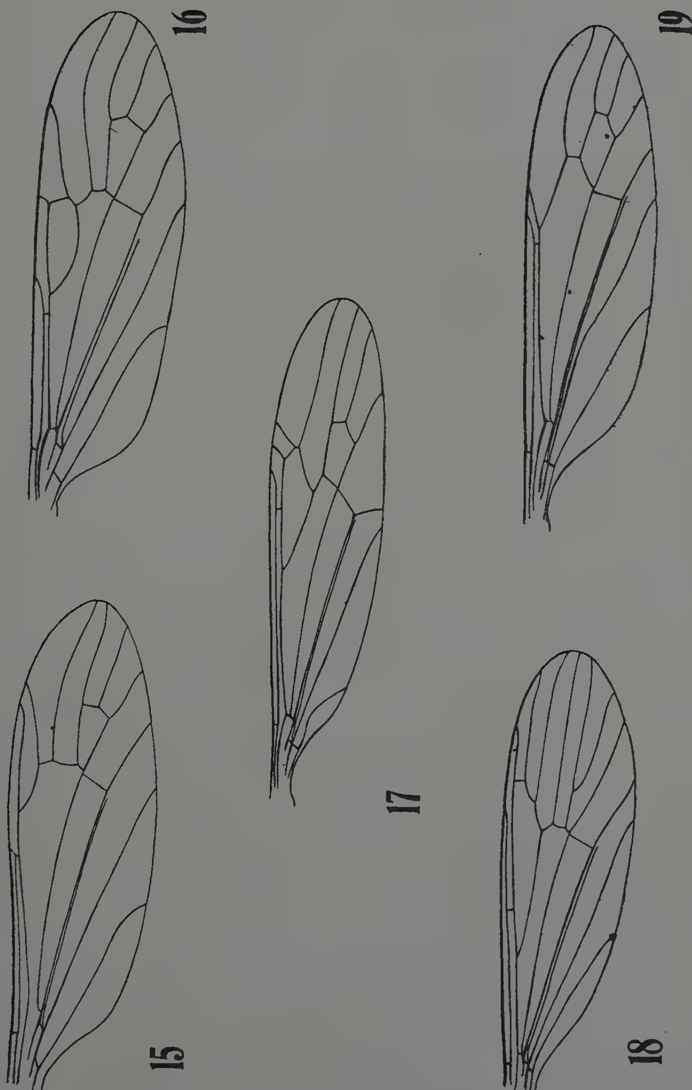
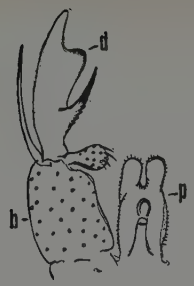
PLATE XLVII





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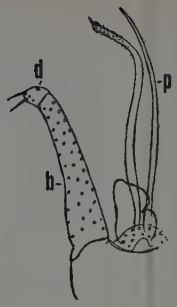

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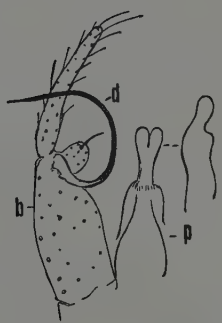

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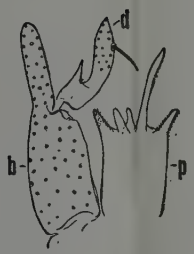

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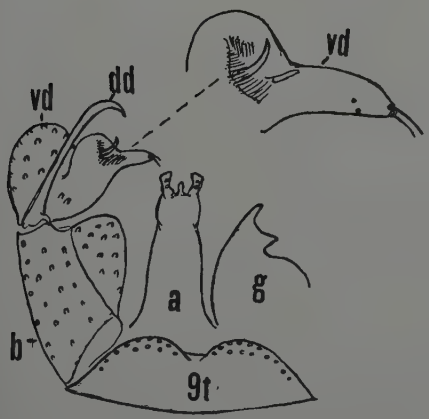

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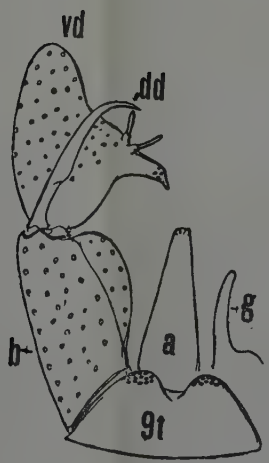


26

FUSARIUM DISEASE OF COFFEE IN COSTA RICA *

By C. Picado T.

The literature on Fusarium diseases of coffee throughout the world is very meagre. Delacroix (4)[1] gives *Fusarium coffeicola* as mildly attacking the leaves of coffee in Africa. Averna Saccá (2) reports the presence of *F. pallens* in the roots of coffee plants attacked by *Rosellinia* and in some nurseries attacked by *Colletotrichum* sp. in Brazil. It is also found in root lesions produced by nematodes. He reports *F. coffeicola* producing a blackening of the berries and causing their premature falling in Brazil. Fawcett (5) reports a *Fusarium* attacking coffee plants in Puerto Rico, destroying the bark at the base of the stem. He believes the fungus follows injuries produced by implements and insects. The disease may be reproduced by inoculating plants with pieces of diseased tissues. Arndt and Dozier (1) report *F. martii* following injury by the coffee cricket. As a result of the attack, the cortex becomes black and the trees shed their leaves. A consideration of the above facts establishes the malady under discussion as a new disease caused by an undescribed fungus.

HISTORY

It is very probable that the disease under discussion is none other than the one called "Chasparria" by our farmers. For several years it has been present in the coffee plantations, but has failed to attract attention because its presence was limited to a few scattered plants. For the last two years, the disease has been decidely on the increase and suddenly, most unexpectedly, a severe outbreak occurred after the trees had withstood fairly well a long period of drought during the years 1929 and 1930. The rainfall for the last five years was as follows:

	Meters	Inches
1927	2.233	87.91
1928	2.295	90.35
1929	1.775	69.88
1930	1.153	45.39
1931 (11 months only)	2.420	95.27

Following the beginning of the rainy season of this year (1931)

* A contribution from the laboratory of the hospital.

[1] Numbers in parenthesis refer to literature cited.

the trees, instead of initiating new growth, shed their leaves and the new shoots dried up and blackened. Whole plantations, many acres in extent, were completely defoliated.

The disease seems to have had its beginning in the province of Heredia and gradually progressed towards the East, apparently following the direction of the wind. Later, the disease appeared to some extent in Alajuela and more recently, we have seen isolated cases of it about 15 kilometers from the center of the infestation, irrespective of the kind of soil.

LOSSES

An accurate estimate of the losses as a result of the disease is, at present, impossible. Although many of the attacked plants died, many more recovered but made an abnormal growth. In some places, the disease began before the start of the rainy season and when the berries were maturing. As a result, the yield this year will be greatly reduced. Diseased plants, although recovering, will yield less each successive year until the crop will fail to pay expenses. The culture of coffee will then be abandoned.

Expert growers estimate that the crop in the affected areas will be reduced by 25 per cent. At present prices, this means a gross loss of about $100,000.

SYMPTOMS

During the course of the disease both internal and external symptoms are produced. The external symptoms differ depending on whether the disease develops in the spring or autumn.

In the first case, the plants are attacked severally and the course of the disease is more rapid. With the first rains of the spring healthy trees start their new growth and begin to flower. The heavy rains follow these early showers from two to four weeks later; and with them, active vegetative development ensues. Diseased plants, however, fail to renew active growth with the establishment of the rainy season proper and instead, the young, tender shoots produced with the early rains die and become charcoal black (Fig. 1). In some cases the trees begin to shed their leaves, the new shoots stop growing without blackening, but produce abnormal leaves and branches. New plants pruned half a meter from the ground produce new shoots but these are abnormal. Diseased, abandoned fields have plants with their tops dead but with a proliferation of thin, slender, unproductive branches underneath.

In the autumn, the plants are attacked when vegetative growth

is slow and the berries begin to ripen. There is not the rapid defoliation that characterizes the spring symptoms, but instead the disease appears gradually and its course is much delayed (Fig. 4). The invasion, however, is persistent and finally the fruiting branches are destroyed. The berries from such branches are seedless and only those fruits that mature before the branches begin to dry have a normal appearance.

Besides these obvious symptoms, there are others more difficult to detect such as the splitting of the cortex of green branches; a gradual yellowing of the leaves, beginning along the veins, prior to their being shed; dry, sunken areas of cortex tissue and black necrotic are formed in dead branches.

If the cortex of a diseased plant is carefully peeled off, black streaks or filaments running from the roots upwards are evident along the vascular tissue. Sometimes these streaks extend to the medulary rays and the pith. The cortex from such plants is easily removed around the lower part of the stem and the upper part of the root. A carefully pulled plant will have a very large number of its rootlets partially desintegrated, blackened and sometimes totally necrotic. Often the injury extends to the primary and secondary roots.

ETIOLOGY

The disease is produced by *Fusarium anisophilum*, n. sp. Its perfect stage is *Nectaria anisophila*, n. sp. which develops in diseased shade trees.

ISOLATION OF THE FUNGUS

The fungus has been isolated easily by aseptic plantings of pieces of infected roots or bark on sugar agar.[1] From this medium the fungus has been systematically transferred to Richard's [2] solution for further growth. It has also been grown on rice (autoclaved in an equal volume of water), potato, carrot, kidney bean and autoclaved coconut water previously boiled and filtered.

CULTURAL CHARACTERISTICS

On sugar agar initial cultures 3–5 days old always produce a light rose color which soon changes. Subcultures from these are almost white or orange, intense vermillion or violaceous red. After the second day, unicellular conidia $3\,\mu \times 6\,\mu$ are produced, especially

[1] Sugar Agar: Sugar-cane syrup (Panela) 10 per cent; Peptone 1 per cent; Ammonium phosphate 0.5 per cent; Agar-Agar 3 per cent.

[2] Richard's solution: KNO_3 10 grs.; KH_2PO_4 5 grs.; $MgSO_4$ 2.5 grs.; $FeCl_3$ 0.2 Mgms.; Sugar Candy 50 grs.; H_2O 1000 c.c.

so in the red colonies. In the white or orange colonies are found long, thin, 2, 3 or 5 septate conidia with curved ends, measuring 4 μ × 40 μ.

Since the production of a given color can not be safely regarded as an index to the unity of the species under study, various tests were made to elucidate this point. The various subcultures were grown on Richard's solution to which 1 c.c. of a 1 per cent solution of caffeine sulphate had been added for each 100 c.c. of the medium. All the cultures, irrespective of their original color, produced salmon colored colonies. In a few weeks both micro and macroconidia were produced. When transferred to slants macroconidia were produced in 6 days even by the less sporulating types. The presence of caffeine was equally antiseptic to all the subcultures and the same thing may be said of the presence of lactic acid.

Old mycelium grown in Richard's solution when ground gives an acrid odor. Allowed to oxidize by exposure to the air the odor soon recalls that emitted by bed bugs. *F. cubense,* a species very similar to *F. anisophilum,* specially when grown on rice, when similarly treated produces an agreeable fruit-like odor.

Successive plantings in liquid media with the same fungus were found to inhibit the growth if the same species was repeatedly used as the inoculum. To this effect, the apparently different sub-cultures of *F. anisophilum* and also *F. cubense* were grown in Richard's solution in flasks, so as to expose a large surface of the medium to the growth of the fungus. Every two weeks the solution was filtered and replanted with its corresponding fungus. After the third planting, the medium was no longer favorable for the growth of the fungus even when a proportionate amount of the nutritive salts were supplied to each flask. The different subcultures of *F. anisophilum,* irrespective of their color or characteristics, when interplanted in the culture media on which they have been growing failed to develop, but when any one of them was planted on the fluid medium where *F. cubense* has been growing, they made very good growth. When *F. cubense* was planted in its own culture medium it failed to grow, but when planted in any of the media where the various strains of *F. anisophilum* had been growing it also made very good growth.

This method of specific vaccination of the liquid medium has not been used to differentiate the imperfect forms of fungi, but we look upon it as more promising than the present serological tests.

Within the limits of our cultures *in vitro* we feel justified in establishing the unity of the species for the following reasons: (1) Mutation or loss of color; sometimes in the same agar slant. (2) Same coloration in the presence of caffeine. (3) Production of mi-

croconidia and macroconidia irrespective of the original inoculum. (4) Equal sensibility towards antiseptics. (5) Production of same odor producing substances, and (6) same reaction towards vaccinated media.

FRUITING BODIES

After diseased plants have lost their leaves and their branches begin to dry, small epidermic vesicles are found, particularly behind the leaf scar, which contain the sporodochia. These produce either macroconidia or microconidia. Generally, the conidiophores have four segments. If these are thick and short, they will develop into the microconidiophore at the end of which one microconidia usually is present, although rarely there may be two (Fig. 9 *a*). Sometimes the conidiophores are not so uniform and divide into two or three branches.

With *F. cubense,* microconidia and macroconidia are successively produced from the same sporodochium; while in *F. anisophilium* the conidiophoresare differentiated into either one or the other type of conidia.

The microconidia are ovoid, uniloculated, and average $3\,\mu \times 7\,\mu$ in size. The macroconidia are in general almost straight, with the ends bent, and average $4\,\mu \times 40\,\mu$. Some are 6 or 7 septate and measure $7\,\mu \times 60\,\mu$. Intermediate forms with one septum, measuring $4\,\mu \times 20\,\mu$ are also found.

The conidiophores are not always produced immediately under the epidermis; frequently they are found beneath the cortex directly on the vascular tissue.

Intercalary chlamydospores, spherical and rarely elliptical, are generally formed in sugar agar plates and old carrot slants. When grown on kidney beans, macroconidia are always produced within 8 days irrespective of the type of inoculum used, the medium on which it has been growing previously or its ability to produce microconidia in such medium.

The easiest procedure to obtain conidia is by making an emulsion of the finely ground mycellium in sterile water and inmersing young coffee shoots in it. Within two or three weeks conidiophores bearing conidia with their silky paraphyses are abundantly produced.

THE PERFECT STAGE

The perfect stage of *F. anisophilum* was found in the lesions of diseased shade trees. We have classified it as *Nectria anisophila* n. sp. Its description is as follows:

Perithecia isolated or in colonies, globular, simple or with projections arising from the vesicles covering their walls, deep orange almost vermellion in color measuring 270 μ — 340 μ in diameter; asci cylindrical 70 μ — 90 μ × 12 μ —14 μ; spores 8, monoseptate, usually incline, uniseriate, 14–15 μ × 6–7 μ, hyaline, smooth, elliptic or fusoid; paraphyses filiform, branching, twisted (Fig. 9).

This species differs from *N. inga* Chardon, (**3**), by having larger perithecia and by the presence of branched and twisted paraphyses. On germination *N. inga* failed to produce the form *F. anisophilum*. The codinial stage of *N. anisophila* reproduced in all its details the cultural and pathogenic reaction produced by *F. anisophilum*. Ascospores cultures of *N. anisophila* are able to reproduce the perfect stage when grown on coffee shoots in a moist chamber provided the source of the ascospore has been *Inga* trees and not coffee trees. Subcultures made from said fungus growing on coffee shoots fail to produce the perfect stage when reinoculated into coffee shoots in a moist chamber. *By passing thru the coffee plant as a host the fungus losses its ability to produce its perfect stage.* This explains our failure to obtain the ascigerous stage when making cultures of the fungus isolated from diseased coffee plants. The Nectria form may be obtained from any of the cultures isolated from coffee by growing them on branches of *Inga* in a moist chamber.

SECRETIONS OF THE FUNGUS

In order to study the hosts reaction towards the secretions of the fungus, cultures of *F. anisophilum* were grown in 500 cc of Richard's solution in one liter flasks. *F. cubense* was similary grown for use as a check. At the end of one month the culture fluids were filtered and diluted in various proportions. Young coffee shoots and 12 day old kidney bean plants cut under water were inmersed in the various solutions. In every case, corresponding checks were made by heating the various fluids for 5 minutes at 100°C.

The results warrant the following conclusions:

1. The fungus secretes a thermolable diastase capable of digesting the tissues of coffee or kidney beans in contact with it.

2. There is a blackening of the coffee tissues immersed in the fluid.

3. Both of these reactions are greatly inhibited by heating the fluids.

Similar tests were made using emulsions of the ground mycelium. Coffee branches immersed in this fluid without previous heating reacted in a similar way as diseased plants in the field; the leaves

wilted, became clorotic beginning at the veins, soon dropped and the branches died. *There is, therefore, a toxic action effective at a distance capable of inducing a chlorotic condition and shedding of the leaves.*

INOCULATIONS

Direct, soil and field inoculations were made. Direct inoculations of the leaves and branches were never successful; the inoculum used was a sporulating culture a few days old. Inoculations into thick roots of old trees also failed and the wounds healed normally.

In pots, with sterilized soil, which was inoculated with the fungus, plants in the butterfly stage, i. e., with only the cotyledons expanded; and plants one year old having six pairs of leaves were planted. Three plants were set in each pot, 2 were left uninjured and the third one was punctured in the root crown. Checks were similarly treated. The uninjured plants in the butterfly stage did not seem to contract the disease but the injured ones are greatly retarded in their growth, a reaction not evident in the check plants (Fig. 4). On the other hand, the one year old plants were immediately attacked by the fungus which destroyed the cortex from the base of the stem upwards (Fig. 5), whether or not punctured at the time of planting.

The resistance of the small seedlings towards the disease might be explained on the basis of the antiseptic action of the caffeine towards the fungus, since they contain practically all the alkaloid present in the seed.

Keeping inoculated plants at a temperature of 18°–22°C. seems to greatly diminish the activity of the pathogene or increase the resistance of the plant to its invasion. The year old plants in inoculated soil may, at that temperature, remain apparently healthy for at least 5 months. The same plants taken outdoors (45°C. under sunlight) begin to defoliate in about 5 weeks and by that time the cortex of the branches has begun to dry. They behave as if inoculated at the time of transferring them to the open.

In our experimental plot, 25 two year old plants brought from areas not infected were set in 5 rows, 2½ meters apart and inoculated as follows: The middle row was inoculated at the time of planting with pieces of diseased roots around each ball of earth. The remaining rows were allowed to establish themselves and two weeks later the soil around them was inoculated with cultures of the fungus. One row was not inoculated to serve not as an absolute but as a relative check. At the end of a month, the row inoculated at the time of planting had 15 branches completely defoliated and begin-

ning to blacken while the remaining 4 rows had a total of 16 defoliated branches. Two weeks later the row inoculated at the time of planting had 18 defoliated branches; those inoculated fifteen days later had 7, 10 and 16 defoliated branches respectively and the check row had only 4 defoliated branches. By this time the fungus had spread through the soil to the check row and could be isolated from the soil around it. At the end of two months the plants were showing typical symptoms of the disease; the stems had gray colored cracks surrounded by black tissue (Fig. 6) and the new shoots in the base of the branches died back, showing that although defoliation occurs from the lower branches towards the top ones, death follows afterwards from the top towards the base.

Proliferation of rootlets followed the destruction of the roots by the fungus (Fig. 7). The fungus was recovered from these disease roots and sporodochia were present in the defoliated branches.

As previously stated inoculations performed in the thick roots of old trees failed to reproduce the disease for 5 months and the inoculum failed to enter the host through the injury. After this period, however, plants were infected. A close examination revealed that the inoculum spread through the soil and later attacked the young, fine roots.

OTHER HOSTS

Kidney Beans.—By an accidental contamination in the laboratory this legume was found to be susceptible to *F. anisophilum.* Repeated inoculations demonstrated that the black kidney beans were resistant, but the white and red varieties highly susceptible. The roots were destroyed and cankers developed at the base of the stem as a result of the infection, but the vascular tissue was not penetrated (Fig. 8).

This plant was used in the field as an index host to study the spread of the fungus in the soil. It was found that in two weeks the fungus spread 2½ meters through the soil.

Lima Beans.—A small planting of this legume growing near our inoculated plots was attacked also by the fungus.

Flame Tree (*Poinciana regia*).—A natural case of the disease has been found on this tree under which diseased wood was piled. The fungus *F. anisophilum* was isolated from the diseased tissues.

Shade Trees.—In view of the fact that most coffee shade trees are legumes, a close examination of them was made. Lesions and symptoms similar to the ones produced by the coffee disease were found. Tissue plantings of affected roots and branches gave cultures of *F. anisophilum.*

Gliricidia maculata, Inga sp., and *Erythrina* sp. were found to contract the disease. The perfect stage of the fungus, *Nectria anisophila* was found in the dead branches of these hosts.

CONTROL

Mechanism of Infection.—Taking into consideration the prolonged periods of drought and the fact that the disease appeared within a a few kilometers of the capital at a time when the increased use of electricity for heating and as a substitute for other sources of fuel, brought about a decrease in the price of timber, we are led to conceive the origin of this disease in the following manner. In the old days, it was a regular practice among coffee growers to prune their coffee shrubs and shade trees, and to sell the waste wood so obtained, there being a ready market and quite a big demand for it. This demand has fallen off and there is no market for this wood. The practice of pruning is gradually disappearing and those growers who still practice it, pile up the twigs and branches either in the coffee plantations or in places nearby. Every one of these piles has become a breeding place for millions of *Nectria* which have scattered and invaded the surrounding leguminous trees and coffee shrubs. The spread of the disease following the light rains, and its increased virulence during the rainy season is thus explained.

Once the soil becomes infested, the fungus attacks the small rootlets and the fate of the plant depends upon the severity of the infection and upon the fertility of the soil. In those cases where the infection is severe, even though the plant produces new roots the fungus will make much headway, and the plant will become seriously affected. In poor soils where root development is checked, even slight infections will prove disastrous to the plantation. On the other hand, in good soils the plants will tolerate and withstand a slight infection.

Defoliation may be ascribed to two reasons: Not enough water to supply the demands of transpiration and photosynthesis, and the toxic action of the enzymes or catabolic secretions of the organism. Coffee seedlings planted in pots filled with inoculated soil thrive very well for some months at least, provided they are kept under cover, in a humid atmosphere, and are watered regularly. These seedlings soon loose their leaves after they are planted in the open in spite of our efforts to gradually accustom them to the effects of direct sunlight. The roots of those plants which are grown under shade, and

of those grown without shade are injured. Plants grown in pots continued to live although the dead tissue in the cortex extended as far as the woody cylinder. They continue to live even if the bark at the base of the stalk is stripped off.

The presence of the fungus in the branches is due to secondary infection. In spite of repeated inoculations and spores sprayed on the branches of healthy plants, we have not been able to produce the disease. Everything tends to prove that initial infection takes place through the roots. Cultures from root material have always yielded the *Fusarium anisophilum* only, while culture from branch material show other genera of fungi also.

Some years ago, several *Poinciana Regia* tres were imported from the island of Puerto Rico, and planted along a road leading to the Insane Asylum near our laboratory. One specimen was planted near a shed which is used for storing timber. Since this timber came from an infested zone, we asked our collaborator Mr. Elías Vicente, to examine it for *Nectrias*. Not only did he find plenty of them, but he also called our attention to the fact that the *Poinciana* which was growing nearby, was beginning to show symptoms of a disease similar to that attacking coffee and *Gliricidia*, namely: defoliation, drying up and blackening of the branch tips, and black streaks along the vascular region. We proceeded to dig out and wash several roots. Upon examining them we found that they exhibited bark lesions. Out of 20 cultures made in sugar agar Petri dishes, 17 of them showed a *Fusarium* which had all the characteristics of *F. anisophilum*.

Infection was possibly due to the proximity of the tree to the infected wood pile, since the other *Poinciana* trees are still healthy.

Control Measures:

Studies on the life-history of the pathogene makes us advocate the following control measures:

1. In infested regions, the seed beds should be made in as poor a soil as possible with the idea of obtaining by natural selection, only those plants which survive because of unusual resistance.

2. In new plantings, the use of shade trees susceptible to the disease, should be discontinued.

3. Prune and burn all dry twigs and branches, from coffee shrubs and shade trees alike.

All these protective measures should be adopted simultaneously, and legislation to that effect should be passed. Any source of in-

fection which is not destroyed might result in the spread of the disease by the wind, and the infection of the soils.

Acknowledgments.—Before bringing this paper to an end, the author wants to express his indebtedness to the laboratory staff for their helpful collaboration; to Mr. Ingo H. da Silveira-Grillo for his valuable information about the *Fusariums* attacking coffee in Brazil; to Mr. Bienvenido Matienzo of the Department of Agriculture and Commerce of Puerto Rico for his helpful suggestions in gathering the bibliography; to D. Elías Vicente for his devoted help; to Mr. Arturo Roque, Assistant Phytopathologist of the Insular Experiment of Puerto Rico for translating the manuscript into English and to the Insular Experiment Station of Río Piedras, Puerto Rico. for publishing the paper.

Literature Cited

1. Arndt C. H. and Dozier H. L.—"The Haitian Coffee Tree Cricket"—Journal of the Dept. of Agriculture of Porto Rico—**15** (2) : 325–335—1931.
2. Averna Saccá R.—"Molestias Cyptogamicas do Coffeeiro" Secretaría de Agriculture, Sao Paulo, Brazil—1917.
3. Chardon, C. E.—"Mycological Explorations of Colombia"—Jour. Dept. of Agric. of Porto Rico **14**(4) 195–369—1930.
4. Delacroix—"Les maladies et les ennemies des Cafeiers"—Paris—1900.
5. Fawcett, G. L.—"Fungous Diseases of Coffee in Porto Rico"—P. R. Agri. Exp. Station, Bulletin **17**—1915.

Explanation of Plates

PLATE XLIX

Fig. 1. New shoots die back producing abnormal forms.
Fig. 2. Abandoned tree, top dead, abnormal branches arising from below.
Fig. 3. Plant attacked while bearing its crop.

PLATE L

Fig. 4. Plants in "butterfly" stage. Plant at extreme right was punctured. Note retarded growth.
Fig. 5. One year old plant on inoculated soil showing lesions along stem.
Fig. 6. Splitting of the stem.

PLATE LI

Fig. 7. Root proliferation following destruction of normal roots by *F. anisophilum.*

Fig. 8. Inoculated kidney beans showing canker. Check in the middle.

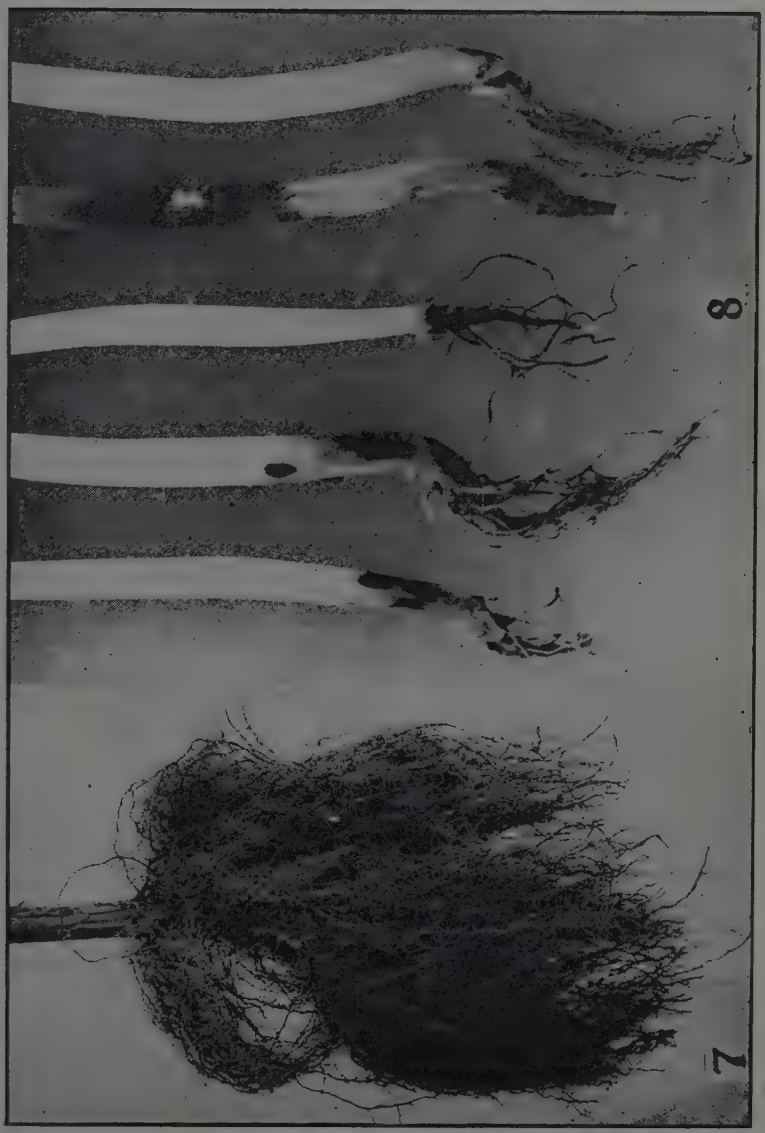
PLATE LII

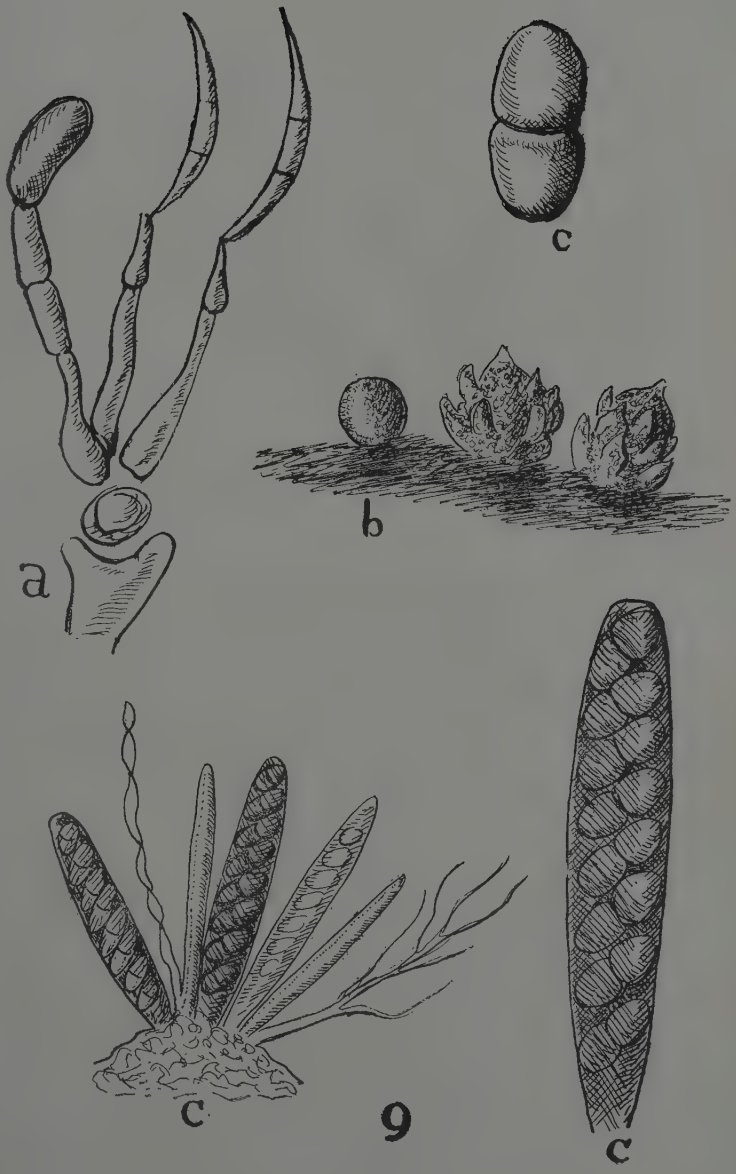
Fig. 9. (*a*) Conidiophores bearing microconidium and macroconidia. (*b*) Perithecia, (*c*) asci, paraphyses and (*d*) spores of *N. anisophila.*

PLATE XLIX

PLATE L

PLATE LI

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9

THE GROWTH OF HERPETOLOGY IN THE PUERTO RICO AND VIRGIN ISLAND AREA

CHAPMAN GRANT, *Major, U. S. Army.*

The earliest writers, Navarette, Oviedo, Casas and Herrera, writing in the latter part of the 15th century make no mention of our reptiles, according to de Armas in his "La Zoologica de Colon y de los Primeros Exploradores de America". They mention reptiles in Santo Domingo and on the Costa Firme only.

1654. Dutertre treats of the reptiles and amphibians of the Lesser Antilles and the Virgin Islands as a whole. He was probably plagiarized by de Rochefort in 1658 and later. Their description of the iguana; its habits and its use by the indians is graphic and probably authentic.

1788. Fra Inigo Abbad y Lasierra speaks of three species as occurring in Puerto Rico. This is the first mention of Puerto Rican reptiles.

1793. H. West wrote on the reptiles of St. Croix and St. Thomas, listing 7 species.

1796–98. Mr. Andre-Pierre Le Dru, a botanist, recorded 12 species from Puerto Rico, but no scientific cognizance is given to his herpetological work.

1863. J. Reinhardt and C. F. Leuthen published the first list of any scientific value, recognizing 10 species of reptiles and amphibians.

1868. E. D. Cope listed 15 species from Puerto Rico.

1876. W. Peters recognized 21 species.

1882. Agostin Stahl published his Catalogue. At this time 23 species were known.

1904. Dr. Leonard Stejneger recorded 35 species in a most scholarly work.

1928. K. P. Schmidt and in 1930 Thomas Barbour recognized 43 species from the Puerto Rico Area and an additional 10 from the Virgin Islands.

1932. The present list comprises 62 species from the Puerto Rico Area and 28 from the Virgin Islands of which 13 species occur on parts of both groups; a total of 77 species exclusive of marine turtles, but inclusive of extinct and introduced forms. The writer has described 11 new species in this Journal, one in Copeia and several remain to be described in my collection of 7,200 specimens.

KEY TO THE FOLLOWING LISTS:

n — New species described by the writer.
f — First local record of a known species.
r — Reestablished as a valid species.
z — Extinct locally or wholly.
? — Local occurrence questioned. If in first column the validity of species is questioned.
i — Introduced.

Some of the data in the following lists was kindly furnished by Miss Doris Cochran.

Herpetological list of species from the Puerto Rico Area		Mona	Puerto Rico	Vieques	Culebra	Virgin Islands
Bufo lemur	Cope 1868		x			
B. turpis	Barbour 1917					x
B. marimus i	Linnaeus 1758		x i			
Leptodactylus albilabris	Gunther 1859		x l	x	x	x
L. Fallax i	Muller 1923		x 2 i			
Eleutherodactylus portoricensis	Schmidt 1927		x 3			x f
E. gryllus	Schmidt 1920		x			
E. locustus	Schmidt 1920		x			
E. cramptoni	Schmidt 1920		x			
E. antillensis	R. & L. 1863		x	x	x	x
E. brittoni	Schmidt 1920		x			
E. wightmani	Schmidt 1920		x			
E. richmondi	Stejneger 1904		x			
E. monensis	Meerwarth 1901	x				
E. unicolor	Stejneger 1904		x			
E. karlschmidti	Grant 1931		x n			
E. cochranae	Grant 1932					x n
E. cooki	Grant 1932		x n			
E. lentus	Cope 1862					x
Hemidactylus brookii	Gray 1844		x f 4			
H. mabouia	Jonnes 1868			x f		x
Thecadactylus rapicaudus	(Houthuyn) 1782					x
Phyllodactylus pulcher	Gray 1830		x f			
Sphaerodactylus grandisquamis	Stejneger 1901		x r			
S. macrolepis	Gunther 1859					x 5
S. klauberi	Grant 1931		x n			
S. roosevelti	Grant 1931		x n	x n		
S. nicholsi	Grant 1931		x n			
S. townsendi	Grant 1931		x n	x n		
S. danforthi	Grant 1931			x n	x n	
S. monensis	Meerwarth 1901	x r				
S. gaigeae	Grant 1932		x n			
Iguana iguana i	Linnaeus 1758					x i
Anolis cuvieri	Meerem 1820		x	x		x ?
A. roosevelti	Grant 1931				x n	
A. cristatellus	D. & B 1837		x	x	x	x
A. acutus	Hallowell 1856					x
A. gundlachi	Peters 1871		x			
A. stratulus	Cope 1861		x	x	x	x
A. evermanni	Stejneger 1904		x			
A. pulchellus	D. & B. 1837		x	x	x	x
A. krugi	Peters 1871		x			
A. poncensis	Stejneger 1904		x			
A. monensis	Stejneger 1904	x r				
A. newtonii ?	Gunther 1859					x
Cyclura stejnegeri	Barbour & N. 1916	x				
C. mattea Z	Miller 1918					x z
C. portoricensis Z	Barbour 1919		x z			
C. pinguis	Barbour 1916					x
Celestus pleii	D. & B. 1839		x			
Ameiva wetmorei	Stejneger 1904		x			
A. eleanorae	Grant & Roosevelt 1931		x 6 n			
A. polops	Cope 1862					x
A. exsul	Cope 1862		x	x	x	x
A. alboguttata	Boulenger 1896	x				
A. birdorum	Grant 1932		x n 7			
Amphisbaena caeca	Cuvier 1829		x			
A. fenestrata	Cope 1861					x
A. bakeri ?	Stejneger 1904		x			
Mabuya sloanii	Daudin 1803		x			
M. semitaeniatus	Wiegmann 1837	x r		?	x r	x r
Typhlops sp. 8	Shaw 1802		x	x f	x f	
T. richardii	D. & B. 1844					x r
T. monensis ?	Schmidt 1926	x				
T. rostellatus	Stejneger 1904		x			
Epicrates inornatus	Reinhardt 1843		x			
E. sp. 9	Grant 1932					x n
E. monensis	Zenneck 1898	x				
Dromicus stahli	Stejneger 1904		x			
D. exiguus	Cope 1862			?	?	x
Alsophis antillensis	Schlegel 1837			?	x	x
A. portoricensis	R. & L. 1863		x			
A. variegatus ?	Schmidt 1926	x				
A. sancti-crucis	Cope 1862					x
Pseudemys rugosa	Stahl 1882		x	x f		
P. descussata	Peters 1876		x			
Testudo tabulata i	Walbaum 1782		x z i			x i

Notes:

1. The Puerto Rico form seems to be distinct from that of the Virgin Islands.
2. Introduced by the Experiment Station of Mayagüez in 1929 again in 1932 from Dominica without evidence of establishment as yet.
3. I believe this name includes two species.
4. Misidentified by earlier writers as being *H. mabouia.*
5. This species has recently been confused with *S. grandisquamis* and *S. monensis.*
6. Known only from Caja de Muertos island.
7. Known only from Diablo Key off Fajardo.
8. This group of the genus is in need of revision. I hope to report on my series of over 100 from 7 islands.
9. To be described.

In the Virgin Island List:

St. Croix includes Buck Island.

St. Thomas includes; Water Island, Hassell Island, Buck Island Saba Island.

St. John includes; Congo and Lovango Keys.

St. James includes: Little St. James, Dog Island.

Tortola includes; Guana, Buck, Salt and Peter Islands.

Herpetological list of species from the Virgin Islands		St. Croix	St. Thomas	St. John	Virgin Gorda	Anegada	St. James	Tortola	Just Van Dyke
Bufo turpis	Barbour.....1917	.....	.....	.....	x	.....	.....	.....	.....
Leptodactylus albilabris	Gunther.....1859	x	x	x f	.....	x	.....	x	x
Eleutherodactylus lentus	Cope.....1862	x	x	.....	.....	.....	.....	.....	.....
E. antillensis	R. & L.....1863	.....	x	x f	.....	.....	.....	x	.....
E. portoricensis	Schmidt.....1927	.....	.....	x f	.....	.....	.....	x f	.....
E. cochranae	Grant.....1932	.....	x n	x n	.....	.....	.....	.....	.....
Hemidactylus mabouia	Jonnes.....1868	x	x	x	.....	.....	.....	x	x
Thecadactylus rapicaudus	(Houttuyn)..1782	x	x	.....	.....	.....	.....	.....	.....
Sphaerodactylus macrolepis	Gunther.....1859	.....	x	x f	x	⋈	x f	x	.....
Iguana iguana	Linnaeus.....1758	.....	x	.....	.....	.....	.....	x f	.....
Anolis cuvieri	Merrem.....1820	.....	.....	.....	.....	.....	.....	x ?	.....
A. cristatellus	D. &B.....1837	.....	x	x f	x	⋈	x f	x	.....
A. acutus	Hallowell....1856	x	.....	.....	.....	.....	.....	.....	.....
A. stratulus	Cope.....1861	.....	x	x f	.....	.....	.....	x	x
A. pulchellus	D. & B.....1837	x	x	x f	x	x	x f	x	x
A. newtonii ?	Gunther.....1859	x	.....	.....	.....	.....	.....	.....	.....
Cyclura mattea	Miller.....1918	.....	x z	.....	.....	.....	.....	.....	.....
C. pinguis	Barbour.....1916	.....	.....	.....	.....	x	.....	.....	.....
Ameiva polops	Cope.....1862	x	.....	.....	.....	.....	.....	.....	.....
A. exsul	Cope.....1862	x ?	x	x	.....	x f	x f	x f	.....
Amphisbaena fenestrata	Cope.....1861	x	x	x	.....	.....	.....	x f	.....
Mabuya semitaeniatus	Wiegmann...1837	x	x	x ?	.....	.....	.....	x f	x
Typhlops richardii	D. & B.....1844	x ?	x	x f	.....	.....	.....	x f	.....
Epicrates sp	Grant.....1932	.....	.....	.....	.....	.....	.....	x n	.....
Dromicus exiguus	Cope.....1862	.....	x	x	.....	.....	.....	x f	.....
Alsophis antillensis	Schlegel.....1837	.....	⋈	x ?	x	.....	x f	x f	.....
A. sancti-crucis	Cope.....1862	x	.....	.....	.....	.....	.....	.....	.....
Testudo tabulata	Walbaum....1782	.....	x f	x f	.....	.....	.....	.....	.....

HERPETOLOGICAL NOTES

CHAPMAN GRANT, Major, U. S. Army

Aristelliger cochranae

Aristelliger cochranae was described as a new species in this Journal, Vol XV, pp. 399–400. Noble and Klingel have described a new genus in American Museum Novitates, No. 549, p. 4, under the name of *Aristelligella* to which they refer our new species.

Sphaerodactylus

The same authors, p. 11 et seq. describe a new *Sphaerodactyl* and in discussing variation and sexual differences state: ". . . We are indebted to Major Grant for his discovery of a reliable secondary sexual character of value in distinguishing sexes [the "escutcheon" of the male] . . . As a matter of practice we find the hypertrophy of these scales the [escutcheon] less diagnostic of sex than another male character which we believe has not been hitherto described. The posterior lip of the cloaca is very much broader in the *adult* male than in the *adult* female [italics mine] . . . The only adult males in our series which do not show this distinctive lip are not well preserved or are so bent that the cloacal lips do not meet in the normal way. In checking through the series of sphaerodactyls in the American Museum we find the lip less variable than the hypertrophied scales [escutcheon]."

My study of a series of 2,035 specimens of nine species from the Puerto Rico Area has shown that the escutcheon is visible in newly hatched specimens and not confined to "adults". We do not read in what way the escutcheon is "less diagnostic" than the character of cloacal lips found only in "adults" and invisible in "not well preserved" or "bent" specimens. We read that "the lip is less variable than the" escutcheon. The escutcheon is present regardless of variability on all males of whatever age, state of preservation or bending. Nothing is claimed for species occurring outside of the Puerto Rico Area.

Further we read: "Grant (1931) lays considerable emphasis on sexual dichromatism as a diagnostic species character in his sphaerodactyls from Puerto Rico and adjacent areas . . . In *inaguae,* [*S. inaguae*] we have been able to establish definitely that there is considerable variation in color, and the sexes of adults cannot always

be distinguished by difference in coloration . . . In view of the wide limits of variation in *inaguae,* it seems probable that other species of *Sphaerodactyls* are more variable than Grant and others have assumed."

In my description of new species and rediscriptions of known species the following points have been brought out in various articles in this Journal:

There is no sexual dichromatism whatever at any age in *S. klauberi, nicholsi, townsendi, gaigeae* or *monensis.*

Sexual dichromatism is present and forms an *almost* infallible character in *adults* of *S. grandisquamis, macrolepis* and *danforthi.*

Sexual dichromatism most marked from newly hatched to adults in *S. roosevelti.*

Bibliography

Herpetological titles of the Puerto Rico and Virgin Island Areas published since the works of L. Stejneger, 1904, Smithsonian Inst. No. 129 and K. P. Schmidt, 1928, N. Y. Acad. Sci. Vol. X. Part 1 or omitted by them. Exclusive of articles published in this Journal consecutively from July, 1931.

Amaral, A. do.
1929. Lista Remissiva dos Ophidios da Regiao Neotropica. Mem. Inst. Butantan, IV. pp. 126–217.

Atiles, Francisco del Valle.
1887. Los Animales Vertebrados Utiles. Puerto Rico. pp. 28–30. (List of reptiles and their food habits.)

Barbour, Thomas.
1930. A List of Antillean Reptiles and Amphibians. Zoologica, XI No. 4 pp. 61–116.
1930. The Anoles I. The Forms Known to Occur on the Neotropical Islans. Bull. M.C.Z., LXX, No. 3.

De Sola, C. Ralph and Greenhall, Arthur M.
1932. Two Species of Terrapin in Cuba: The Antillean Terrapin *Pseudemys rugosa,* and the Cuban Terrapin, *Pseudemys decussata.* Copiea, No. 3. pp. 129–133.

Dexter, Raquel R.
1932. Habits of the Imported Toad, Bufo marinus, in the Sugar Cane Sections of Puerto Rico. International Soc. of Sugar Cane Technologists. Bull. No. 74 Puerto Rico. pp. 1–6.

Dutertre.
1654. Histoire Naturelle et Morale des Iles Antilles de L'Amérique, etc. This work includes St. Croix. Plagerized 1658 by L. de Poincy and in 1681 by C. de Rochefort.

GRANT, CHAPMAN.
1931. A New Frog from Porto Rico (*E. karlschmidti*) Copeia, No. 2. pp. 55–56. text fig. Notes on the Ameivas of Porto Rico, id. p. 62. Notes on *Bufo marinus* (D) id. p. 62.
1931. Notes on *Pseudemys stejnegeri*, Copeia No. 3. p. 142.

MAY, D. W.
1929. Surinam and Dominican Toads. Report of the Puerto Rico Agri. Exp. Sta., Oct. fig. 3. p. 4.

NOBLE, G. K. AND KLINGEL, G. C.
1932. The Reptiles of Great Inagua Island, British West Indies. Am. Mus. Novitates, No. 549 pp. 4–6 and 13–16. (Refers to *Sphaerodactyls* of P. R.)

STULL, OLIVE GRIFFITH.
1931. Corrections to Some Recent Papers on Neotropical Snakes. Bull. Antivenin Inst. of Amer. V. No. 2. pp. 39–41. (Refers to Boas of P. R.)

TAYLOR, CHAS. EDWIN, F.R.G.S.
1888. Leaflets from the Danish West Indies. p. 192.

WEST, H.
1793. Bidrag til Beskrivelse over St. Croix med en Kort Udsigt over St. Thomas, St. Jean, etc., p. 317.

HERPETOLOGICAL NOTES

The Journal has published articles on a collection of 7,235 reptiles and amphibians collected during 1931–1932 in the Puerto Rico and Virgin Island Areas. The first articles appeared in the July, 1931 number; and in each succeeding number to date. The collection is now in the Museum of the University of Michigan.

ON THE LIFE-HISTORY AND SYSTEMATIC POSITION OF THE ORGANISMS CAUSING DRY TOP ROT OF SUGAR CANE

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In 1920 Matz (**5, 6, 7**) described an organism which caused a disease of the sugar canes in Puerto Rico. He referred it to the genus *Plasmodiophora,* under the name *P. vascularum* Matz. In 1929 Dr. Melville T. Cook (**1**) made a further investigation and transferred the organism to the genus *Ligniera* on the grounds that since it caused no hypertrophy of the host tissue it should be relegated to that genus which was characterised by causing no hypertrophy. Certain peculiarities described by Dr. Cook made me doubtful if this organism was really a species of the genus *Ligniera,* and induced me to write to Dr. Cook and ask him if he would send me a specimen slide in order to compare it with the other species of the genus with which I was familiar. In reply Dr. Cook sent me all the slides he had and was kind enough to invite me to make what use I cared of the slides and to publish any results obtained in this journal. I very gladly accepted this kind offer as I at once saw that the organism differed very considerably from the other species of the genus *Ligniera,* and, in fact, from any of the species of the Plasmodiophoraceae which I had seen.

There are certain characteristics which, after a study of the Plasmodiophoraceae, one appreciates as always occurring in all the species. The most important is the appearance of the plasmodium. Even from the time when the nucleus of the original amoeba divides into two the most noticeable feature is the presence of the nuclei. Irrespective of what staining method is employed, the karyosomes of these nuclei stand out as deeply staining bodies, spherical in outline and surrounded at a little distance by a clearly defined nuclear membrane. The chromatin may not be so easily seen since it lies around the nuclear membrane, or it may be that it is the presence of the chromatin which makes the nuclear membrane stain up when a dye is employed. Whichever is the case, these nuclei stand out clearly in the plasmodium, and, in slides stained with Iron Alum and Haematoxylin the plasmodia appear as a greyish mass spotted all over with small black bodies. Division of these nuclei is rarely seen, and

stages in which there is any disappearance of the characteristic karyosome are so infrequent that in no slide would more than one per cent of the plasmodia show any other stage. Only when the plasmodia are mature does the karyosome disappear, but even there the nuclear membrane remains recognisable until chromatin again is seen in the nuclei. In Dr. Cook's slides, which were stained with various dyes, I was at once struck by the almost complete absence of any recognisable nuclei in the plasmodia. Dr. Cook noticed this himself and says in his paper (1) "Nuclei could not be seen in any of the preparations until the spores began to form and sometimes the nuclei were not visible even when spore formation was well advanced". This characteristic is unlike anything which I have seen in any of the species of the Plasmodiophoraceae which I have studied.

Being unable to reconcile the fungus with any of the other Plasmodiophoraceae, and finding it difficult to determine the systematic position of the organism present, I wrote again to Dr. Cook asking him for a supply of material fixed specially for me. Dr. Cook in reply sent me a quantity of material fixed in Bouin's Fluid which was made up as follows:

Formaldehyde (formalin)	25 parts
Picric acid (satur. aq. sol.)	75 parts
Acetic acid	5 parts

The material was sectioned after embedding in wax and serial sections from 6–10 μ in thickness were cut. These were then critically examined and compared with the slides previously sent me by Dr. Cook. At the same time I asked Dr. E. J. Butler F.R.S., of the Imperial Mycological Institute, Kew, to examine the slides and give me the benefit of his opinion on the parasite. In addition Mr. S. F. Ashby also examined and reported on the slides. Their observations agreed with the conclusion which I had also arrived at, namely that more than a single organism was present in the diseased canes, and I now propose to consider in detail the results of my study of the disease.

There are three distinct types of spherical or subspherical bodies present in the cells. The largest and most conspicuous are thin walled and in some slides frequently collapsed bodies 16–21 μ in diameter (Pl. LIII fig. A). These occur almost exclusively in the larger vessels and are frequently developed in such numbers that they completely block the whole of the passage. The second type are smaller, measuring 14–16 μ in diameter. These have thicker walls which are double-contoured and contain a definite nucleus in which one or sometimes two nucleoli can be made out. They are not so frequent

and are rarely found in the large vessels though they may occur in the phloem or sometimes in the xylem parenchyma or even in the cortex. From their size and structure they correspond to the spores of *Ligniera vascularum* described by Dr. Cook. The third spore type is somewhat irregular in shape, measuring from 10–12 μ in diameter, and when fully grown is seen to be made up of a number of small spherical bodies each containing a well-marked nuclear mass which stains up clearly.

In addition to these there appear two distinct types of amoeboid material from which the spore types are differentiated. The most recognisable type consists of large masses which despite repeated staining by various aniline dyes fail to shew any recognisable structure or nuclei (Pl. LIII fig. D). These correspond to Dr. Cook's plasmodia. They are restricted to the large vessels and also definitely form part of a life-cycle with the largest spore type since it has been found that the latter become differentiated from them. The second amoeboid structure consists of much smaller elements, which are restricted to the phloem and xylem parenchyma. These, shewing structure and nuclei with a single well-defined nucleolus, have been repeatedly observed.

Finally there are present minute spherical bodies which stain very deeply. These frequently appear associated with the three other spore types and Mr. Ashby thinks that they are probably bacteria.

There seems no question that the organism which is chiefly responsible for the disease of Dry Top Rot of Sugar canes is this large amoeba and its associated large spore type, and I will first give an account of its life history. I propose to call it *Amoebosporus vascularum*.

The Life-History of Amoebosporus vascularum sp. nov.

The amoeba, in the earliest stage found, consists of a uniform mass of protoplasm in which no differentiation of any kind is apparent. The protoplasm appears granular after fixation, whether fixed with Bouin's Fluid or with Flemming's solution. No nuclear structure could be seen in any of the preparations whatever dye had been used to stain it. These amoebae occur in the spiral and annular tracheids and in the pitted vessels of the vascular bundles. As they increase in size the amoebae as a rule do not shew any further differentiation (Pl. LIV fig.), but occasionally the protoplasm develops vacuoles (Pl. LIV fig. 4). When mature the amoebae completely fill the vessel in which they have been growing and it appears that this acts as a stimulus for reproduction. The protoplasm

becomes traversed by lines in which solid material is laid down. From this the walls of the large spherical cysts, already referred to, (Pl. LIV fig. 6), are formed. These cyst are, at first, spherical and contain a single nucleus. This is generally the first stage in which nuclei become clearly recognisable. It is possible in the early stages in cyst development, to stain them sufficiently to see something of their internal structure. The nucleus is central, surrounded by a granular cytoplasm in which highly refringent granules are present. These are not dissolved by dilute hydrochloric acid and appear to consist of silicates. After a time the nucleus divides into a number of parts and around each a small spherical mass of protoplasm is formed and a cell wall is secreted. These bodies are difficult to see since the wall of the cyst has by this time become hard and stains do not penetrate easily (Pl. LIII fig. B). There is no doubt, however, that spores are formed (Pl. LV fig. 8). Whether the cyst breaks at once or remains intact for some time could not be determined, but eventually the spores are shed and come to lie around the empty cysts, Pl. LV fig. 7. During the formation of the cysts all the protoplasm of the amoeba is not used up, (Pl. LIV fig. 5), and after the discharge of the spores much cytoplasm is found lying around them, so that they come to be embedded in the protoplasm of the original amoeba (Pl. LV fig. 7).

The germination of the spores is difficult to observe, and the author is not certain that the following stages form part of the same life-cycle. As far as he can see the spores germinate to produce a small spherical body containing a clearly marked nuclets (Pl. LIV fig. 1), in which there is a vacuole associated with the nucleus. The protoplasm later becomes more vacuolated as the amoeba grows (Pl. LIV fig. 2). The sequence of stages shewing the development between that represented by Pl. LIV fig. 2 and Pl. LIV fig. 3 have not been found, but the author is quite certain that the large amoebae found are derived from these small bodies.

The life-cycle of this organism may be graphically represented by the following diagram:

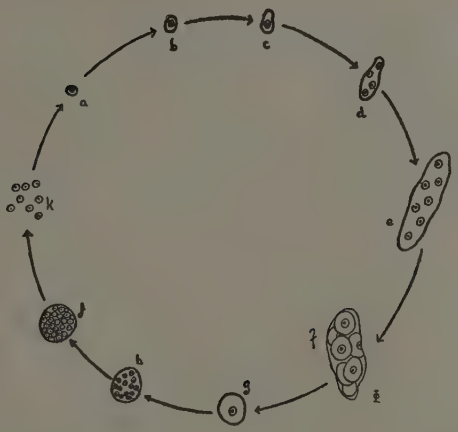

Diagram of Life-cycle of *Amoebosporus vascularum*. *a.* spore; *b.* germinated spore; *c. young amoeba*; *d.* multinucleate amoeba; *e.* mature amoeba; *f.* formation of cysts within amoeba; *g.* single cyst; *h.* multinucleate cyst; *j.* formation of spores within cyst; *k.* separation of spores.

The Life-History of Amoebosporus saccharinum sp. nov.

The life-history of the second organism present is in many respects similar to the first, but it differs chiefly in the smaller size of the amoebae, cysts and spores. Moreover it does not appear to be of great economic importance since there is little evidence that it seriously affects the host. It is proposed to call this *Amoebosporus saccharinum*.

The earliest stage found consists of uninucleated amoebae which occur in some of the cortical cells as well as in the phloem and xylem parenchyma, but never in the xylem vessels. These amoebae are irregular in shape and are composed of very fine granular protoplasm quite distinct in character from that in *A. vascularum*. There is a central nucleus with a nucleolus lying in its centre. The nucleus divides by a process which appears to be mitosis, though insufficient stages were seen to determine this point with certainty. Concurrently with nuclear division the amoeba increases in size (Pl. LV figs. 10–12). Large plasmodia were not found though those containing up to six or seven nuclei occurred. The amoebae finally became surrounded with a cyst wall and the contents divided up into a number of small

spherical cells each of which contained a single nucleus. (Pl. LV fig. 13). Pl. LV fig. 14 shews one in which the cyst has split and the contents migrated out into the surrounding cell. Fixation must have occurred during this process, since, while some of the spores remain within the cyst, others have already left it. As far as could be made out these bodies are provided with an apical flagellum, and at this early stage are pyriform in shape, though later they became rounded. There is a single nucleus which is situated either in the centre or towards the anterior end. The development of a flagellum does not take place until after the spores have left the cyst, and then not in every instance. In the majority the spores resemble those of *A. vascularum* in character but are smaller in size.

A third type of spore-like body was found in some of the cells which is represented in Pl. LV fig. 16. These bodies may be connected with one of the life-cycles described but it seems very improbable. They occur relatively rarely and may represent a stage in the life history of some other organism. The bodies are spherical, with a double wall of appreciable thickness, and contain a single dark staining body which appears to be a nucleus. No stage in their further development has been seen.

Discussion

It has been a matter of considerable difficulty to separate these two organisms, and only the culture of the two organisms separately on artificial media would prove conclusively that their life-histories are correct. Since I was working so far from the actual locality in which the disease occurred it was impossible for me to attempt to carry out such experiments, and I have had to rely exclusively upon a study of fixed material.

Assuming that I have made no mistake in the life-histories which I have indicated, it will be seen that neither organism bears any relationship with the Plasmodiophoraceae. With the exception of those stages represented in Pl. LV figs. 9–12 there is nothing which shews any similarity to any species of the Plasmodiophoraceae now recognised (**2**).

In the structure of the protoplasm and in the general appearance these two organisms undoubtedly belong to the Rhizopoda. Many Protozoa occur in plant tissue, though a critical study of them has not been made. In a recent paper (**3**) a short account has been given of one living in the roots of *Apium nodiflorum*, though in this instance the cysts have not been found to divide up into spores. These Protozoa occur in plants living in damp or badly drained soil.

In *Apium nodiflorum* only plants growing by the side of a lake in a very marshy soil have been found to contain these amoebae. In the present instance it has been recorded that the disease is most common in low-lying badly drained soil (1). Such a position would be suitable for the development of saprophyte soil-inhabiting amoebae, which have become secondarily modified as parasites in plant tissue. I have been unable to determine the precise pathological effect which these organisms produce in the host, but, as Dr. Cook points out, the quantity of the organism is not sufficient to explain the effect by assuming that it merely causes a blocking of the larger xylem vessels. It has been repeatedly noticed that there is a marked tendency for the vessel to break during sectioning at a point where the parasite is developing which seems to indicate that an alteration has been produced in the material composing the cell wall, and that therefore the organism is not living merely as a saprophyte in the vessels. This is further confirmed by slight changes in the reactions to stains which is exhibited by these areas.

These organisms have been previously regarded as a single species under the name *Plasmodiophora vascularum* and *Ligniera vascularum* and although there are stages in the life-cycles which have not been completely investigated it seems desirable to give them scientific names since they are of definite economic importance to sugar canes in Puerto Rico. It is therefore proposed to place them in a new genus under the descriptive name *Amoebosporus*. The larger and more important will be called *Amoebosporus vascularum*, since it lives chiefly in the xylem vessels; and the smaller will be called *Amoebosporus saccharinum*. As regards their systematic position, the presence of amoebae and also cysts suggests relationship with the Rhizopoda and in particular with the family Lobosa in which pseudopodia are short, blunt, or absent. It is proposed, therefore, to place this new genus provisionally in that Family.

SYSTEMATIC DIAGNOSIS

The following Latin diagnoses of the new genus and the two species have been prepared.

Amoebosporus–gen. nov.

Amoebae quibus in cellulis hospitis cystes formatae sunt. Cystes in multis sporis dividiuntur. Sporarum amoebae formatae. In radicibus et caudicibus plantarum palustrium.

1. *A. vascularum* sp. nov.

Syn. *Plasmodiophora vascularum* Matz. pr. p.

Amoebae magnae. Cystes 16–22 μ diam. In cellulis lignis hos-

pitis formatae sunt. Cystes in sporis dividiuntur. Sporae 2–3 μ diam. Sporae in amoebis pariuntur.

Hab. In radicibus et caudicibus *Saccharum officinari* in Porto Rico, West Indies.

2. ***A. saccharinum*** **sp. nov.**

Syn. *Plasmodiophora vascularum* **Matz. pr. p.**

Amoebae minutae. Cystes 10–12 μ diam. In cellulis phloemis et corticis hospitis formatae sunt. Cystes in sporis dividiuntur. Sporae 1.5–2 μ diam. Sporae in amoebis pariuntur.

Hab. In radicibus et caudicibus *Saccharum officinari* in Porto Rico, West Indies.

I wish to record my grateful thanks to Dr. Melville T. Cook for the very willing assistance which he has given me both by the loan of slides and also in collecting and fixing suitable material. I am also indebted to Dr. E. J. Butler, F.R.S. and Mr. S. F. Ashby of the Imperial Mycological Institute, Kew, for their assistance in examining and reporting upon some of the microscopic preparations.

February 1932.

REFERENCES

1. **Cook, Melville T.** Life-history of *Ligniera vascularum* (Matz) Cook. Journ. Dept. Agric. Porto Rico. **13**: 13–29. 1929.
2. **Cook, W. R. Ivimey,** The parasitic slime moulds. Hong Kong Naturalist. 3 No. 3. 1932.
3. _____, The occurrence of Amoebae in plant tissue. Annales de Protistologie. **3**: 197–200: 1932.
4. _____ and Schwartz, E. J. The Life-History, cytology and method of infection of *Plasmodiophora Brassicae* Woron., the cause of Finger-and-Toe disease of cabbages and other Crucifers. Phil. Trans. Roy. Soc. London. **218** B: 283–314. 1930.
5. **Matz, J.** A new vascular organism of the Sugar Cane. Journ. Dept. Agric. Porto Rico. **4**: 41–46. 1920.
6. _____ La enfermedad de la Raíz de la Caña Azúcar. Estación Experimental Insular Porto Rico. Circ. **56** Pp. 12. 1921.
7. _____ Dry Top Rot of Sugar Cane. Journ. Dept. Agric. Porto Rico. **6**: 28–47. 1922.

Description of Plates

The drawings were made with a camera lucida at table level, with tube length 160 mm. using a Zeiss 2 mm. (N. A. 1.4) objective and compensating ocular × 15 (Fig. 1–2, 8), compensating ocular × 7 (Figs. 3, 9–15) and compensating ocular ×15 (figs. 4–7, 16)

The photomicrographs were made a Zeiss 4.2 mm. (N. A. 0.65) objective. The drawings and photographs have been reproduced

without reduction, and actual magnifications are given after the description of each figure.

PLATE LIII

Fig. A.—A photomicrograph of *A. vascularum* shewing a mass of the cysts lying in a large xylem vessel. × 100

Fig. B.—A photomicrograph of a small number of cysts of *A. vascularum* showing the division of the contents into separate spores. × 750

Fig. C.—A photomicrograph of a transverse section through a vascular bundle showing the cysts in the central vessel surrounded by amoebae of *A. vascularum*. × 300.

Fig. D.—A photomicrograph of a large xylem vessel showing the presence of a mature amoeba of *A. vascularum* lying within it. × 900

PLATE LIV

Figs. 1–8.—*Amoebosporus vascularum.*

Fig. 1.—The spores after escape from the cyst showing the nucleus and associated vacuole. × 2475

Fig. 2.—A later stage in the development of the spore after liberation into the vessel. The contents are becoming vacuolate, and the nucleus less distinct. × 2475

Fig. 3.—A large amoeba lying in and completely filling a large vessel shewn in tranverse section. The amoeba at this stage does not shew any internal structure. ×1155

Fig. 4.—A drawing of a large vascular strand shewing the presence of amoebae in several of the vessels. Three amoebae are present in the largest vessel one of which is shewing vacuolation. × 825

Fig. 5.—A large amoeba in longitudinal section shewing the formation of cysts from within the amoeba. These cysts are now empty and some of the spore from them are seen lying in the upper part of the amoeba. × 825

Fig. 6.—Four cysts shewing an early stage in the division into spores. The nuclei are visible. × 825

PLATE LV

Fig. 7.—Part of a large amoeba containing both cysts and spores. The cysts are empty and their contents have passed out into the surrounding protoplasm which has not been involved in cyst formation. × 825

Fig. 8.—A large mature cyst just before breaking. Shewing the contents divided up into a large number of spores each of which has a well-marked nucleus. × 2475

Figs. 9–16.—*Amoebosporus saccharinum.*

Fig. 9.—A very young amoeba in which the protoplasm is just becoming differentiated. × 1155

Fig. 10.—A slightly older amoeba developing within a small cell of the xylem parenchyma. × 1155

Fig. 11.—An amoeba after the nucleus has begun to divide up. This amoeba was growing in the phloem tissue. × 1155

Fig. 12.—An older amoeba with six nuclei developing in a cell of the phloem tissue. × 1155

Fig. 13.—A late stage in the formation of cysts from the amoeba, shewing the contents dividing up prior to fragmentation. × 1155

Fig. 14.—A cyst lying apparently quite free in a xylem vessel. The cyst has broken and some of the contents has escaped into the surrounding tissue. These spores appear to possess a single flagellum. × 1155

Fig. 15.—Two young spores after escape and migration into the cortical tissue. The nucleus is clearly seen and the flagellum was visible. × 1155

Fig. 16.—Spherical spores lying in a cell of the cortical parenchyma. It is doubtful if these represent a stage in either of the species described. × 825

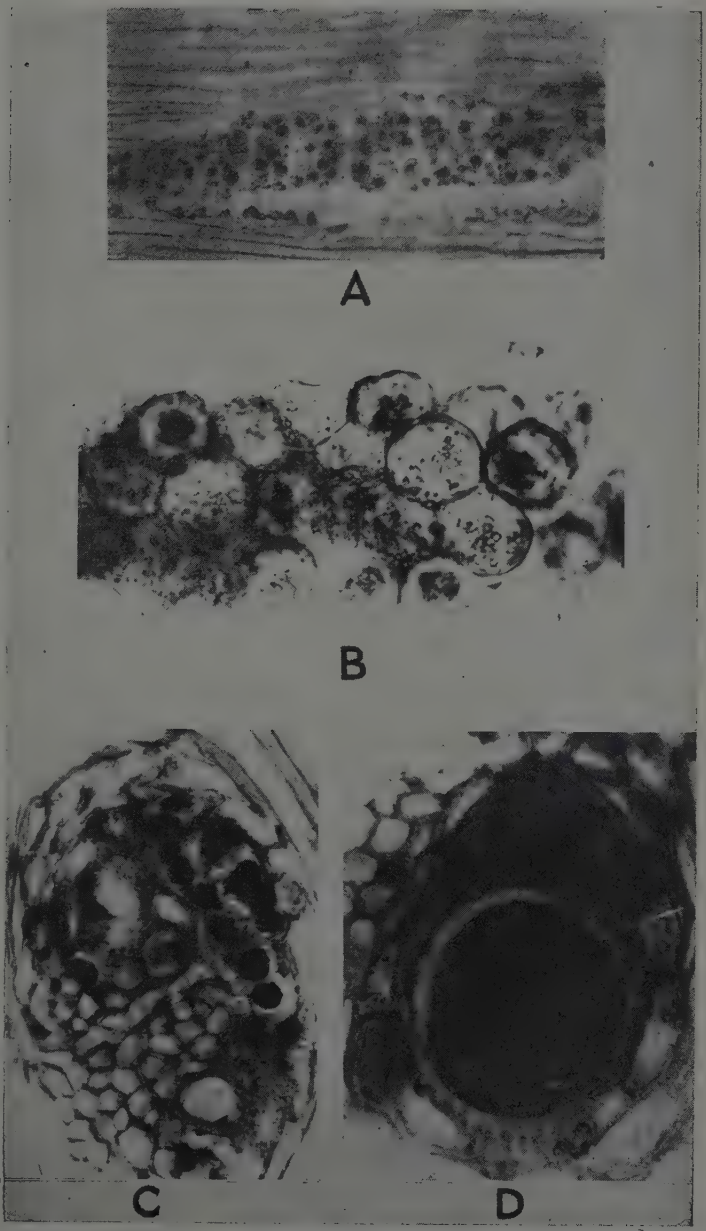
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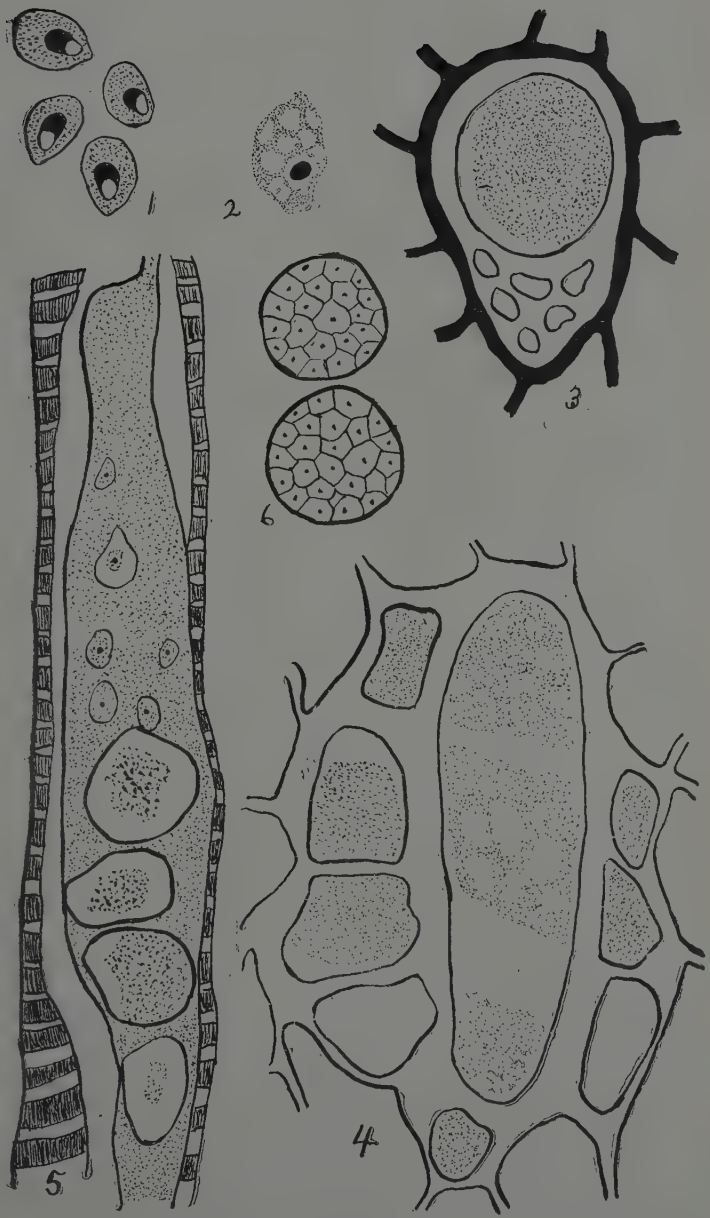
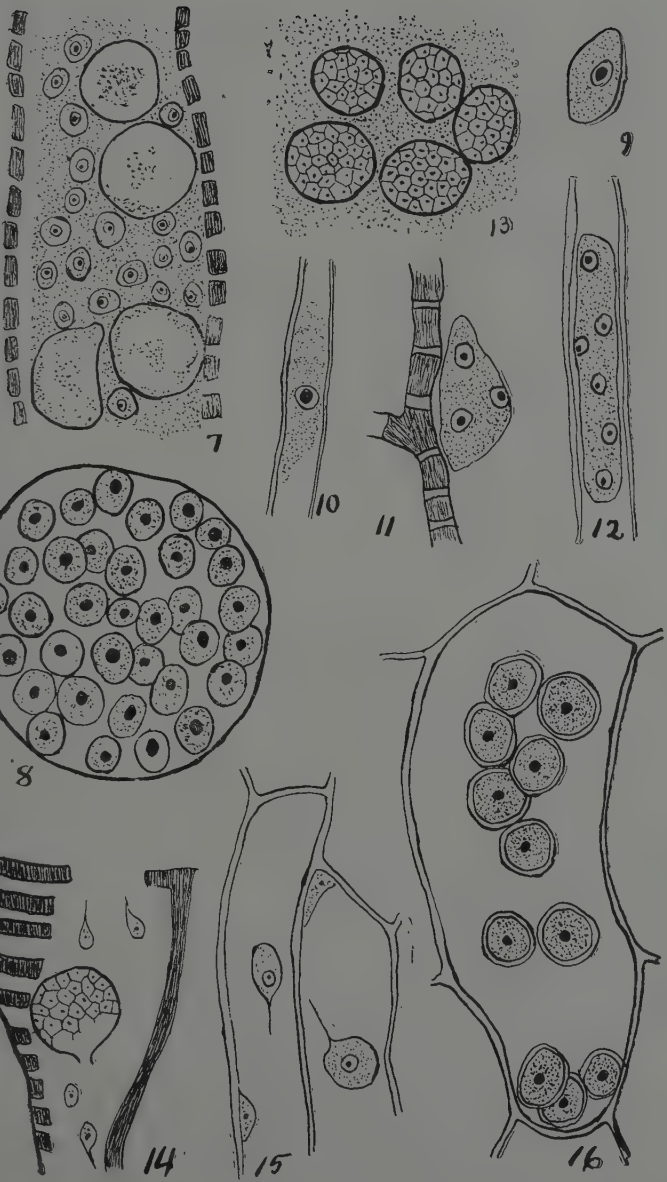
PLATE LIV

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INTRODUCTION OF LEPTODACTYLUS FALLAX IN PUERTO RICO

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The Federal Experiment Station of Mayagüez has made two importations of *Leptodactylus fallax,* the "mountain chicken" or large edible frog of Dominica, with the object of establishing this species in Puerto Rico.

The first lot of 12 frogs was received from Dominica July 1929. They were released on the shore of the Cartagena Lagoon, a location which had proved highly favorable for the development of the toad, *Bufo marinus,* introduced by the station in 1920 from Barbados. Whether or not the frogs persisted is not known. Later attempts to definitely locate them failed.

In June of the present year a second and larger lot was imported from the same source. Ninety individuals were received alive. Fifty were released on the bank of the reservoir located on the station farm just north of Mayagüez, and forty were released on the river bank near Las Vegas.

Their loud call from one point or another on the station grounds was frequently heard at night thereafter, and in November a young frog of this species was found.

This species is shown in colors in the National Geographic Magazine, May, 1932 and under the plate is the legend: An Edible Species In Some Danger of Extermination. Let us hope that its introduction into Puerto Rico may not reduce the danger of extermination, but that it may also supply the Island with an epicurean dish not previously procurable.